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AIR FORCE

SCIENTIFIC RESEARCH

GEOGRAPHY

VOLUME 1

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AD-446866

AIR FORCE SCIENTIFIC RESEARCH
BIBLIOGRAPHY
1957-1958

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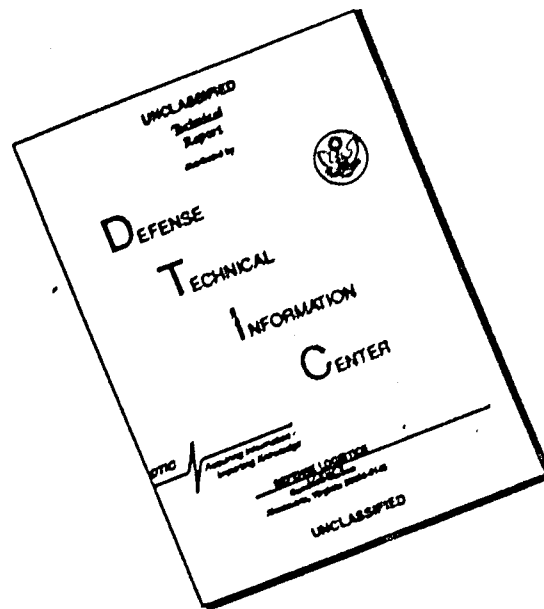
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FOREWORD

In 1961 the Air Force Office of Scientific Research brought out volume one of the Air Force Scientific Research Bibliography, containing abstracts of publications resulting from its support of fundamental research in the sciences from 1950 through 1956 in the Nation's colleges, universities, and research organizations.

For the first time, a Federal agency sponsoring fundamental research undertook to provide comprehensive access to the work it had funded. The value of that effort may be measured first by the demand for the book itself, and secondly by the favorable response from those who create the scientific literature, those who use it, and those whose work it is to ensure its availability.

AFOSR research supported from 1957 through 1958 is covered in this volume, prepared by the Special Bibliographies Section of the Science and Technology Division, Library of Congress.

The sponsorship of high quality research of itself does not ensure the creative transformation of new science into technology on a timely basis. There must also be effective communication among fundamental researchers, and between them and the scientists and engineers with responsibility for the solution of technological problems.

These volumes are part of AFOSR's effort to facilitate that communication. Their publication is the result of the firmly held conviction that a granting organization's responsibility for basic science continues beyond publication by the researcher in the literature.

William J. Price

William J. Price
Executive Director

PREFACE

Prolegomenon

Time's arrow, entropy, is a measure of disorder, of the tendency for hot drinks to cool, of toys to become distributed in an ankle-deep layer of plastic potsherds, of papers to disappear without a trace. The Creation of the universe from chaos (or ylem) was a magnificent act of negative entropy; things have been getting worse, entropy-wise, ever since.

Whenever an experiment is performed in the laboratory, it is paid for by, inter alia, an increase in entropy. Reagents are dissolved, reacted, and thrown down the sink; electrical energy turns to heat. The price paid in increase in entropy is always, inevitably, greater than the amount of information gained. A measure of the experimenter's efficiency is the ratio between the entropy spent to buy information and the negative entropy of the information so bought.

A similar test of efficiency might be applied to organizations sponsoring research. Funds are received, in a state of minimum entropy. They are dispersed, with an increase in entropy, to various institutions and thence to scientists who in turn, with a further increase of entropy, spend them to buy information. This is dispersed through the myriad channels of scholarly publications, to a state of maximum entropy. The needs of science or scientists may well have been served by this process; the full needs of the sponsoring organization are not.

There is, for example, the role of the organization as a negative entropy device itself. It lives in a warm soupy broth of unsolicited proposals (with a few propositions thrown in for good measure). From these it selects those few, within the limits of an always inadequate budget, which it deems most relevant to the purposes for which it was established--the general welfare, the cure of cancer, or in the case of the Air Force Office of Scientific Research, the future needs of the United States Air Force. The sponsoring organization, then, acts as a meta-corporate author towards papers of more probable relevance in a given field of research.

There is the simple cybernetic desirability of providing a feedback loop.

There is the practical problem of having something to show for funds expended; something more than a simple numerical tally or even a listing of titles of papers produced.

Negentropy costs money; in the case of this bibliography, a cent for every four dollars spent in supporting the research. The average AFOSR publication, based on some \$159 million spent in the support of research, costs somewhere between \$18 and \$19 thousand to produce (dividing the cost of the research by the number of publications ensuing). We think that the money spent to produce this bibliography was a sound investment.

Scope

This is the second volume of a continuing bibliographic series. The first volume, issued in 1961, covered the period 1950 through 1956.

This volume of the bibliography includes, within the limitations of the law of diminishing returns, abstracts of all technical notes, technical reports, journal articles, books, symposium proceedings, and monographs produced and published by scientists supported in whole or in part by the Air Force Office of Scientific Research during calendar years 1957 and 1958.

The Air Force Office of Scientific Research supports fundamental research in the five major scientific disciplines: physics, chemistry, engineering sciences (subsuming mechanics and propulsion), life sciences (both biological and behavioral, but not medical), and mathematics (including, during the period of this bibliography, the information sciences). Thus, these abstracts are multi-disciplinary, their common link being their support by AFOSR.

Sources Searched

References, reports, and clues to the existence of reports were found by searching the indexes and report collection of the Air Force Office of Scientific Research Technical Library,

and the collection of the Defense Document Center (formerly ASTIA). Detailed searches were made of each contract file in the several AFOSR Directorates and Divisions.

In addition, cover-to-cover searches were made of over 200 scientific journals, issued mostly in the time period 1957-1962.

Form of Entry and Arrangement

Inherent in the organization of this book is the concept of the reports within a contract as an unanalyzed monographic series. Reports are posted chronologically and/or alphabetically under contracts, these in turn under laboratories, and these under contractors. This does, in fact, provide a rough subject grouping, with the detailed subject index leading into clusters of like reports.

The abstracts are coded for possible future machine searching. A three letter mnemonic code designates the contractor; two digits are reserved for the contract; and three for the report within the contract. While the same codes have been retained in Volume II for those contractors and contracts which appeared in Volume I, the addition of new codes, and of interpolated code numbers, because of new contracts, has made it impossible to maintain the codes strictly in the same alphabetical and chronological order as that of the entries, that is, by contractor and contract number. Hence, the running page headings used in the present volume can serve only as approximate guides to the areas of interest. The searcher is urged to make use of both the Subject Index and the Code Number Index as aids in finding material on a given subject.

The form of entry is, in general, that being used for DDC catalog cards, i. e.: source of the document; title; personal author, if any; date; pagination; report number; contract number; and accession number.

Availability of Reports

The principal accession or control numbers, which indicate the locations of reports in collections are:

- AD ASTIA Document, or Accessioned Document: available at
 DDC (Defense Documentation Center), Cameron Station,
 Alexandria, Virginia 22314
- TIP Technical Information Pilot: available at above address.
- ATI Air Technical Index: available at above address.
- PB Publication Board: for sale by the Office of Technical
 Services, Department of Commerce, Washington, D. C.
 20235

The fact that a report is abstracted in this book means that a copy of this report existed at the time the abstract was written; it should not be construed to imply that AFOSR necessarily has a copy available for distribution. Those seeking reports should go to the cited agencies, not from AFOSR.

Indices

A detailed subject index, arranged alphabetically, and a special subject classification for mathematics, have been provided. In addition, there are a contract index, an OSR control number index, a personal author index, and the "Code Number Index" already mentioned. The latter is arranged alphabetically by code number, and indicates the page or pages on which the material from the corresponding source (contract) is to be found. Finally, the "Code Guide," relating the three-letter codes to the respective contractors, has been placed at the beginning of the text.

Acknowledgements

Many people have made this book possible. The work has been fostered and encouraged by the previous Commanders and Executive Director of the Air Force Office of Scientific Research:

Brigadier Generals H. F. Gregory and B. G. Holzman, Colonels A. P. Gagge and Jack L. Deets, Dr. Knox Millsaps and the present Executive Director, Dr. William Price. The book would have been impossible to produce without the accurate records maintained to the highest standards of bibliographic accuracy by Eleanor Capps, doyenne of documentation in AFOSR. Perhaps, most important of all, has been the cheerful and willing cooperation of the scientific staff of AFOSR in assisting the bibliographers in locating reports and helping with subject analysis.

The bibliographic team has worked under the leadership of G. Vernon Hooker, with general guidance by Dr. Clement R. Brown, Head of the Special Bibliographies Section, Science and Technology Division, Library of Congress. In addition to Mr. Hooker, the chief workers on this volume have been Aaron S. Dann, Doris C. Yates, and Marion S. Carr. Much preliminary work on this and future volumes was done by Mabel H. Duffner, a former member of the group. Other present and former employees of the Section who gave valuable assistance in the work of abstracting, subject indexing, and cataloging of entries included Thomas C. Goodwin, Bruce Blankenhorn, Jack R. Gibson, Louis Aronica, Frank Lupis and Sandra McInnis. Recognition is also due those who participated in the work of preparing the manuscript for publication, especially Mrs. Carr, Patricia Gravatt, Phyllis Martin and Evelyn Briscoe. Duane D. Starbuck of the Library of Congress drew most of the chapter end-plates.

This bibliographic task has been supported and monitored by the Information Sciences Directorate, AFOSR, as part of a continuing research program to study and devise new and better ways of handling scientific and technical information.

Harold Wooster

Washington, D. C.
April 1964

Harold Wooster
Director
Information Sciences

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ARA - Allied Research Associates, Inc., Boston, Mass.	13
AIP - American Inst. of Physics, Inc., New York	14
AMF - American Machine and Foundry Co., Pacoima, Calif.	14
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ARK - Arkansas U., Fayetteville	21
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MED - Méditerranéen de Recherches Thermodynamiques, Nice (France)	465
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PRF - Purdue Research Foundation, Lafayette, Ind.	675
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RCA - Radio Corp. of America, Princeton, N. J.	696
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RCS - Royal Coll. of Science and Tech., Glasgow (Scotland)	727
ROY - Royal Inst. of Tech., Stockholm (Sweden)	728
RUT - Rutgers U., New Brunswick, N. J.	729
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SAU - San Andres U., La Paz (Bolivia)	735
SMI - Smith Coll., Northampton, Mass.	735
SIT - Smithsonian Inst., Cambridge, Mass.	736
SFE - Société Française d'Études et de Realisations d'Inventions Coanda, Clichy (France) . .	739
SCU - South Carolina U., Columbia	739
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STR - Stanford Research Inst., Menlo Park, Calif.	747
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THM - Technische Hochschule, Munich (Germany)	812
TEM - Temple U., Philadelphia, Pa.	815
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TAM - Texas A. and M. Coll., College Station	818
TEX - Texas U., Austin	820
THI - Thiokol Chemical Corp., Denville, N. J.	828
TIL - Tiltman-Langley, Ltd., Surrey (Gt. Brit.)	829
TOR - Toronto U. (Canada)	829
TRI - Trinity Coll., Hartford, Conn.	833
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UPP - Uppsala U. (Sweden)	835

UTA - Utah U., Salt Lake City	842
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WES - Wesleyan U., Middletown, Conn.	882
WRU - Western Reserve U., Cleveland, Ohio	882
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Code Guide

AIR FORCE SCIENTIFIC RESEARCH

ACR	AeroChem Research Labs., Inc., Princeton, N. J.	CON	Connecticut U., Storrs *
AER	Aerojet-General Corp., Azusa, Calif.	COP	Copenhagen U. (Denmark)
ALA	American Inst. of Aerological Research, Pasadena, Calif. *	COR	Cornell U., Ithaca, N. Y.
AIP	American Inst. of Physics, Inc., New York	COU	Columbia U., New York
AIR	Air Force Office of Scientific Research, Washington, D. C.	CRK	Cork U. Coll. (Ireland)
ALA	Alabama Polytechnic Inst., Auburn	CUP	Cambridge University Press, New York
ALF	Alfred U., New York	CWC	Curtiss Wright Corp., Santa Barbara, Calif.
AMF	American Machine and Foundry Co., Pacoima, Calif.	DEL	Delaware U., Newark
AMS	American Mathematical Soc., Providence, R. I.	DET	Detroit U., Mich.
ANS	Aeronutronic Systems, Inc., Glendale, Calif.	DOC	Documentation, Inc., Washington, D. C.
ANT	Antioch Coll., Yellow Springs, Ohio	DTM	David Taylor Model Basin, Washington, D. C.
APS	American Physiological Soc., Washington, D. C.	DUB	Dublin Inst. for Advanced Studies (Ireland)
ARA	Allied Research Associates, Inc., Boston, Mass.	DUK	Duke U., Durham, N. C.
ARD	ARDE Associates, Newark, N. J.	EAS	Eastern Research Group, Brooklyn, N. Y. *
ARK	Arkansas U., Fayetteville	EMM	Emmanuel Missionary College, Berrien Springs, Mich.
ARN	Arnold, Lee, Associates, New York *	EMO	Emory U., Atlanta, Ga. *
ASM	American Soc. of Mechanical Engineers, New York	ESC	Escher Wyss, Ltd., Zurich (Switzerland)
ATE	Ateliers de Constructions Electriques de Charleroi (France)	EXP	Experiment, Inc., Richmond, Va.
ATH	Athens U. (Greece)	FEA	Fairchild Engine and Airplane Corp., Deer Park, N. Y.
ATL	Atlantic Research Corp., Alexandria, Va.	FLA	Florida State U., Tallahassee
AVC	AVCO Manufacturing Corp., Everett, Mass.	FLU	Florida U., Gainesville
BAN	Banos, A., Jr., Los Angeles, Calif.	FOD	Fordham U., New York
BAT	Battelle Memorial Inst., Columbus, Ohio	FOR	Forest Products Lab., Madison, Wis.
BAY	Baylor U., Houston, Tex.	FPS	Forschungsinstitut für Physik der Strahlantriebe, Stuttgart (Germany)
BCU	British Columbia U., Vancouver (Canada)	FRA	Franklin Inst., Philadelphia, Pa.
BEL	Bell Aircraft Corp., Buffalo, N. Y.	FRB	Freiburg U. (Germany) *
BIR	Breda Istituto di Ricerche Scientifiche Applicate all'Industria, Milan (Italy)	FRD	Frederick, Carl L. and Associates, Bethesda, Md. *
BJO	Bjorksten Research Foundation, Madison, Wis.	FRE	Free U. of Brussels (Belgium)
BJR	Bjorksten Research Labs., Inc., Madison, Wis.	FRS	Fresno State Coll., Calif. *
BMB	Bureau of Mines, Bartlesville, Okla.	FRU	Fribourg U. (Switzerland)
BMP	Bureau of Mines, Pittsburgh, Pa.	FSI	Firth Sterling, Inc., Yonkers, N. Y.
BOS	Boston U., Mass.	GDC	General Dynamics Corp., San Diego, Calif.
BRI	Brigham Young U., Provo, Utah	GEB	Geblein, Hans, Bamberg (Germany)
BRM	Birmingham U. (Gt. Brit.)	GEC	Geckler, R. D., Arcadia, Calif. *
BRO	Brown U., Providence, R. I.	GEN	General Electric Co., Schenectady, N. Y.
BRU	Brandeis U., Waltham, Mass.	GEO	George Washington U., Washington, D. C.
BUR	Burden Neurological Inst., Bristol (Gt. Brit.)	GIT	Georgia Inst. of Tech., Atlanta
BUT	Butler U., Indianapolis, Ind. *	GME	Gustad Mental Hospital, Oslo (Norway)
CAL	California U., Berkeley	GNV	Geneva U. (Switzerland)
CAR	Carnegie Inst. of Tech., Pittsburgh, Pa.	GOT	Göttingen U. (Germany)
CAT	Catholic U. of America, Washington, D. C.	GRC	General Research Co., Beverly Hills, Calif.
CDC	Chicago Development Corp., Riverdale, Md.	GTU	Georgetown U., Washington, D. C.
CER	Carter Labs., Pasadena, Calif. *	HAM	Hamburg U. (Germany)
CEX	Combustion and Explosives Research, Inc., Pittsburgh, Pa.	HAR	Harvard U., Cambridge, Mass.
CGT	Compagnie Generale de Telegraphie, Sans Fil (France)	HEB	Hebrew U., Jerusalem (Israel)
CHA	Charyk, J. V., Princeton, N. J. *	HEI	Heidelberg U. (Germany) *
CHI	Chicago U., Ill.	HER	Hermann Föttinger Inst. für Strömungstechnik, Technische Universität, Berlin (Germany)
CIN	Cincinnati U., Ohio	HIL	Miller Helicopters, Palo Alto, Calif.
CIP	Combustion Inst., Pittsburgh, Pa.	HOR	Horizons, Inc., Cleveland, Ohio
CIT	California Inst. of Tech., Pasadena	HRH	Henri-Rousselle Hospital, Paris (France)
CLA	California U., Los Angeles	IAS	Institute for Advanced Study, Princeton, N. J.
CLH	Cedars of Lebanon Hospital, Los Angeles, Calif.	IEN	Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy)
CME	College of Medical Evangelists, Loma Linda, Calif.	ITT	Illinois Inst. of Tech., Chicago
COA	Cornell Aeronautical Lab., Inc., Buffalo, N. Y.	ILL	Illinois U., Urbana
COL	Colorado U., Boulder		

AIR FORCE SCIENTIFIC RESEARCH

INN	Innsbruck U. (Austria)	NAA	North American Aviation, Inc., Downey, Calif.
INS	Institute of the Aeronautical Sciences, Inc., New York	NAT	National Aeronautical Research Inst., Amsterdam (Netherlands)
INT	Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain)	NBS	National Bureau of Standards, Washington, D. C.
INU	Indiana U., Bloomington	NCS	North Carolina State Coll., Raleigh
IOW	Iowa State Coll., Ames	NCU	North Carolina U., Chapel Hill
IQS	Instituto de Quimica Fisica, Madrid (Spain)	NEB	Nebraska U., Lincoln *
IRS	Institut de Recherches Scientifiques et Techniques du Centre-Ouest, Poitiers (France)	NEC	New Mexico Coll. of Agriculture and Mechanic Arts, State College
ISG	Illinois State Geological Survey, Urbana	NEL	Nelson, W. C., Ann Arbor, Mich.
IST	Istituto Nazionale di Ottica, Florence (Italy)	NEU	New Mexico U., Albuquerque
		NHU	New Hampshire U., Durham *
JHU	Johns Hopkins U., Baltimore, Md.	NOA	North American Phillips Co., Inc., Irvington-on-Hudson, N. Y.
KAN	Kansas U., Lawrence *	NOL	Naval Ordnance Lab., Corona, Calif.
KAR	Karolinska Inst., Stockholm (Sweden)	NOR	Northwestern U., Evanston, Ill.
KEN	Kentucky U., Lexington	NOT	Notre Dame U., South Bend, Ind.
KOF	Kofink, W., Karlsruhe (Germany) *	NRC	National Research Council, Washington, D. C. *
KSU	Kent State U., Ohio	NRL	Naval Research Lab., Washington, D. C.
KUE	Kuessner, H. G., Göttingen (Germany) *	NYU	New York U., N. Y.
LAD	Little, Arthur D., Inc., Cambridge, Mass.	ODI	Odin Associates, Pasadena, Calif.
LAV	Laval U., Quebec (Canada)	OHU	Ohio U., Athens
LEH	Lehigh U., Bethlehem, Pa.	OKA	Oklahoma A. and M. Coll., Stillwater
LEY	Leyden U. (Netherlands)	OKU	Oklahoma U., Norman
LIE	Liège U., Brussels (Belgium)	ORL	Orlando Research, Inc., Fla. *
LIT	Litton Industries, Beverly Hills, Calif.	ORS	Oregon State Coll., Corvallis
LOC	Lockheed Aircraft Corp., Palo Alto, Calif.	OSL	Oslo U. (Norway)
LON	London U. (Gt. Brit.)	OSU	Ohio State U. Research Foundation, Columbus
LOU	Louvain U. (Belgium)	OXF	Oxford U. (Gt. Brit.)
LOV	Lovelace Foundation for Medical Education and Research, Albuquerque, N. M.		
LSU	Louisiana State U., Baton Rouge	PAC	Pacific Semiconductors, Inc., Culver City, Calif.
LYD	Lyons U. (France)	PAL	Palermo U. (Italy)
		PAR	Paris U. (France)
MAD	Madrid U. (Spain)	PEN	Pennsylvania U., Philadelphia
MAR	Marseille U. (France)	PIB	Polytechnic Inst. of Brooklyn, N. Y.
MAS	Massachusetts U., Amherst	PIO	Pioneer Industries, Inc., Reno, Nev. *
MAU	Maudsley Hospital, London (Gt. Brit.)	PIS	Pisa U. (Italy)
MDU	Maryland U., College Park	PIT	Pittsburgh U., Pa.
MED	Méditerranéen de Recherches Thermodynamiques, Nice (France)	PLA	Plasmadyne Corp., Santa Ana, Calif.
MET	Metalectro Corp., Bladensburg, Md. *	POL	Politecnico di Milano (Italy)
MGH	Massachusetts General Hospital, Boston	POM	Pomona Coll., Claremont, Calif.
MIC	Michigan U., Ann Arbor	POT	Politecnico di Torino (Italy)
MID	Midwest Research Inst., Kansas City, Mo.	PRF	Purdue Research Foundation, Lafayette, Ind.
MIH	Minneapolis-Honeywell Regulator Co., Hopkins, Minn.	PRI	Princeton U., N. J.
MIL	Milan U. (Italy)	PRO	Propulsion Research Corp., Santa Monica, Calif.
MIN	Minnesota U., Minneapolis	PSM	Pennsylvania Salt Mfg. Co., Philadelphia *
MIS	Missouri U., Columbia	PSU	Pennsylvania State U., University Park
MIT	Massachusetts Inst. of Tech., Cambridge	PSY	Psychological Research Associates, Arlington, Va.
MLL	McMillan Lab., Inc., Ipswich, Mass. *	PUR	Purdue U., Lafayette, Ind.
MMU	McMaster U. Hamilton Coll., Ont. (Canada)		
MOD	Modena U. (Italy)	RCA	Radio Corp. of America, Princeton, N. J.
MOR	Morton Chemical Co., Woodstock, Ill.	RCS	Royal Coll. of Science and Tech., Glasgow (Scotland)
MPP	Max-Planck-Institut für Physik der Stratosphäre, Hechingen (Germany)	RIA	RIAS, Inc., Baltimore, Md.
MPS	Max-Planck-Institut für Strömungsforschung, Göttingen (Germany)	RIC	Rice Inst., Houston, Tex.
MRT	Martin Co., Baltimore, Md.	ROC	Rochester U., N. Y.
MSU	Michigan State U., East Lansing	ROM	Rome U. (Italy)
MUF	Miami U., Coral Gables, Fla.	ROS	Ross, Chandler C., West Covina, Calif. *
MUC	Miami U., Oxford, Ohio	ROY	Royal Inst. of Tech., Stockholm (Sweden)
MZH	Mount Zion Hospital, San Francisco, Calif.	RPI	Rensselaer Polytechnic Inst., Troy, N. Y.
		RRI	Reed Research, Inc., Washington, D. C.
		RUT	Rutgers U., New Brunswick, N. J.

AIR FORCE SCIENTIFIC RESEARCH

SAN	Sandberg-Serrell Corp., Pasadena, Calif. *	TOR	Toronto U. Inst. of Aerophysics (Canada)
SAU	San Andres U., La Paz (Bolivia)	TRG	Technical Research Group, New York
SCL	Santa Clara U., Calif. *	TRI	Trinity Coll., Hartford, Conn.
SCU	South Carolina U., Columbia	TUF	Tufts Coll., Medford, Mass.
SFE	Société Française d'Études et de Realisations d'Inventions Coanda, Clichy (France)	TUS	Tuskegee Inst. George Washington Carver Foundation, Ala.
SIT	Smithsonian Inst., Cambridge, Mass.	UPP	Uppsala U. (Sweden)
SMI	Smith Coll., Northampton, Mass.	UTA	Utah U., Salt Lake City
SOC	Southern California U., Los Angeles	VIS	Virginia Inst. for Scientific Research, Richmond
SOU	Soundrive Engine Co., Los Angeles, Calif. *	VIT	Vitro Corp. of America, West Orange, N. J.
SRI	Southwest Research Inst., San Antonio, Tex. *	VPI	Virginia Polytechnic Inst., Blacksburg
STA	Stanford U., Calif.	VRU	Virginia U., Charlottesville
STL	St. Louis U., Mo.	WAL	Walz, A., Emmendingen (Germany) *
STR	Stanford Research Inst., Menlo Park, Calif.	WAR	Warner and Swasey Research Corp., New York *
STT	Stevens Inst. of Tech., Hoboken, N. J.	WAS	Washington U., St. Louis, Mo.
SUN	Sundstrand Machine Tool Co., Pacoima, Calif.	WAU	Washington U., Seattle
SYR	Syracuse U., N. Y.	WAY	Wayne State U., Detroit, Mich.
TAI	Tennessee Agricultural and Industrial State U., Nashville *	WEI	Weizmann Inst. of Science, Rehovot (Israel)
TAM	Texas A. and M. Coll., College Station	WES	Wesleyan U., Middletown, Conn.
TEA	Technische Hochschule, Aachen (Germany)	WHE	Westinghouse Electric Corp., East Pittsburgh, Pa.
TEK	Technische Hochschule, Karlsruhe (Germany)	WIS	Wisconsin U., Madison
TEM	Temple U., Philadelphia, Pa.	WRU	Western Reserve U., Cleveland, Ohio
TEN	Tennessee U., Knoxville	WSC	Washington State Coll., Pullman *
TEX	Texas U., Austin	WUR	Würzburg U. (Germany) *
THB	Technische Hochschule, Braunschweig (Germany)	YAL	Yale U., New Haven, Conn.
THI	Thiokol Chemical Corp., Denville, N. J.	ZUR	Zurich U. (Switzerland) *
THM	Technische Hochschule, Munich (Germany)	ZWI	Zwicky, F., Pasadena, Calif.
TIH	Technion - Israel Inst. of Tech., Haifa		
TIL	Tiltman-Langley, Ltd., Surrey (Gt. Brit.)		
TOI	Technical Operations, Inc., Arlington, Mass.		
TOL	Toledo U. Research Foundation, Ohio *		

* These corporate authors appear in volume 1 only.



ACR.01:001 - ACR.01:004

Advisory Group for Aeronautical Research and Development, Paris (France). (AGARD). see North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, Paris (France).

ACR.01:001

AeroChem Research Labs., Inc., Princeton, N. J.

GENERATION OF SUPERSONIC DISSOCIATED AND IONIZED NON-EQUILIBRIUM STREAMS, by D. E. Rosner and H. F. Calcote. Oct. 1958, 33p. incl. illus. diagrs. table, refs. (Rept. no. TM-10) (AFOSR-TN-58-1080) (AF 49(638)300) AD 207590 Unclassified

A small-scale research tool was developed which produces a steady state, supersonic, highly non-equilibrium stream of atoms and ions, with a dc or ac glow discharge as an energy source. Fully expanded streams of air, nitrogen, argon, and helium, at Mach numbers from 2 to 4 were studied. Translational static temperatures in the test section are estimated to be not far from ambient. Preliminary measurements indicated that roughly 50% of the energy input is utilized in dissociating and ionizing the gas while the total efficiency of the device is about 80%. Estimates of the resulting degrees of dissociation and ionization were made on the basis of power balance, pressure, and electrical probe measurements. Non-catalytic surface coatings appeared to exert a strong effect on the convective heat transfer rate. The estimated magnetic field strength necessary to produce easily measurable magnetogasdynamic effects on aerodynamic heat transfer rates is about 10^4 gauss. This field strength is also computed as required for high temperature plasma jets discharging at 1 atm. Since probe observations indicated that the stream carries a net charge, still stronger magnetohydrodynamic interactions are anticipated. (Contractor's abstract)

ACR.01:002

AeroChem Research Labs., Inc., Princeton, N. J.

STEADY-STATE SURFACE TEMPERATURES IN DISSOCIATED HIGH-SPEED GAS FLOWS, by D. E. Rosner. Nov. 1958, 5p. incl. refs. (Rept. no. TP-9) (AFOSR-TN-58-1082) (AF 49(638)300) AD 222523 Unclassified

Also published in Jour. Aero/Space Sciences, v. 26: 384-385, June 1959.

This paper treats the problem of insulated wall temperature assumed by a surface in a partially dissociated supersonic gas stream. Specifically, a simplified theory is developed containing a "catalytic parameter" which, in addition to usual terms, contains a ratio of characteristic diffusion time to characteristic reaction time at the surface. Limiting examples are illustrated with this parameter. (Appl. Mech. Rev. abstract)

ACR.01:003

AeroChem Research Labs., Inc., Princeton, N. J.

GENERATION OF HIGH VELOCITY STREAMS OF ATOMS AND IONS (Abstract), by H. F. Calcote. [1958] [1]p. (AF 49(638)300) Unclassified

Presented at Symposium on Unstable Chemical Species, Los Angeles, Calif., June 23-24, 1958.

A technique has been developed for producing a non-thermal jet of atoms and ions at high velocity. The products of a low temperature electric discharge are expanded through a supersonic nozzle to form a shock free stream. This stream is being employed in aerodynamic studies of non-equilibrium dissociated gas, both in continuum and molecular flow and in measurements of ion and atom recombination rates. Magnetohydrodynamic studies will also be possible with this new tool. The present program is directed toward characterizing the stream in terms of its aerodynamic and physical chemical properties. The measurement of aerodynamic properties and plasma properties, i.e., ion and electron concentrations and electron temperatures is examined, and preliminary results are presented. (Contractor's abstract, modified)

ACR.01:004

AeroChem Research Labs., Inc., Princeton, N. J.

DEVELOPMENT OF A LOW TEMPERATURE PLASMA JET (Abstract), by H. F. Calcote and D. E. Rosner. [1958] [2]p. (Bound with its AFOSR-TN-58-125) (AF 49(638)300) Unclassified

Presented at Conference on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The objectives of this program are to (a) design and fabricate a low-temperature, high-velocity plasma jet, (b) determine characteristic gasdynamic and physical-chemical properties, and (c) investigate possible applications of the results. The potential applications include heat transfer measurements in a highly non-equilibrium dissociated gas and magnetogasdynamic studies in a non-equilibrium partially ionized gas. The apparatus consists of a low-temperature electric-discharge which is expanded through a supersonic nozzle into a low-pressure chamber, producing a jet containing large non-equilibrium concentrations of ions and atoms. The discharges include dc glows, 800 cps glows, and 20 megacycle electrodeless discharges, at pressures of from 10 to 800 mm Hg. The jet exhausts into a pressure of 1-20 mm Hg. The first equipment constructed and tested indicated that roughly 50% of the energy went into dissociating the gas (air) and roughly 5% went into ionization. A shock-free stream was obtained. In addition to air the noble gases helium and argon have been used. The first apparatus has been completely rebuilt, increasing

AER.01:009; AER.02:012-014

the pumping capacity and providing for more accurate measurements. The possibility of achieving magnetogasdynamic effects in the jet can be estimated by evaluation of the magnetogasdynamic parameter Q defined by

$Q = \sigma B^2 L / \rho U$ where ρ = density, U = exhaust jet velocity, L = characteristic length, B = magnetic field strength, and σ = electrical conductivity. Easily detectable magnetogasdynamic effects are expected when Q is of order unity.

AER.01:009

Aerojet-General Corp., Azusa, Calif.

THE EFFECT OF PHYSICAL ADSORPTION ON THE ABSOLUTE DECOMPOSITION RATES OF CRYSTALLINE AMMONIUM CHLORIDE AND CUPRIC SULFATE TRIHYDRATE, by R. D. Schultz and A. O. Dekker. [1956] [6]p. incl. refs. (AF 18(600)1026; continued by AD 18(603)74) Unclassified

Published in Jour. Phys. Chem., v. 60: 1095-1100, Aug. 1956.

The linear decomposition rates for the decomposition reactions $NH_4Cl \rightarrow NH_3 + HCl$ and $CuSO_4 \cdot 3H_2O \rightarrow CuSO_4 \cdot H_2O$ are interpreted on the basis of a modified Langmuir-Hinshelwood bimolecular surface reaction mechanism. An absolute rate treatment (similar in method to that developed by Laidler, Glasstone and Eyring for heterogeneous processes) accounts for the unusually low reaction probabilities per collision of gaseous product molecules with the reaction interface in terms of interference by a physically adsorbed product layer. (Contractor's abstract)

AER.02:012

Aerojet-General Corp., Azusa, Calif.

STUDIES OF THE DECOMPOSITION MECHANISM, EROSION BURNING, SONANCE AND RESONANCE FOR SOLID COMPOSITE PROPELLANTS, by R. [D.] Schultz, L. Green, Jr., and S. S. Penner. [Nov. 1957] [88]p. incl. diagrs. tables, refs. [In cooperation with California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena] (AF 18(600)1048) Unclassified

Also published in Combustion and Propulsion, Third Agard Colloquium; Noise, Shock Tubes, Magnetic Effects, Instability and Mixing, Palermo (Italy) (Mar. 17-21, 1958), London, Pergamon Press, 1958, p. 367-427.

Recent experimental and theoretical studies on the decomposition mechanism, erosive burning, sonance and resonance for solid composite propellants are described. An attempt has been made to discuss recent advances and to define important areas where

additional studies are needed. (Contractor's abstract)

AER.02:013

Aerojet-General Corp., Azusa, Calif.

SOME EFFECTS OF OXIDIZER CONCENTRATION AND PARTICLE SIZE ON RESONANCE BURNING OF COMPOSITE SOLID PROPELLANTS, by L. Green, Jr. [1957] [24]p. incl. illus. diagrs. tables. [AF 18(600)1048] Unclassified

Presented at Twelfth Annual meeting of the Amer. Rocket Soc., New York, Dec. 2-5, 1957.

Also published in Jet Propulsion, v. 28: 159-164, Mar. 1958.

A comparison of four experimental, composite propellant formulations with nominally constant burning rates, tested at 170°F in internal-burning tubular charges partially supported the widely held belief that the tendency toward irregular reaction increases as the energy content of the propellant is raised. However, the highest-energy formulation showed a smooth reaction, apparently as a result of a burning rate lower than was anticipated on the basis of Crawford bomb measurements. The results suggest that the rate of energy release (the product of burning rate, propellant density, and heat of explosion) affords a better measure of the relative stability behavior of various formulations than does either burning rate or energy content alone. A subsequent brief comparison at 170°F of three other composite propellants with constant energy content, but with varying burning rates (obtained by varying the oxidizer particle-size distribution), indicated that the tendency toward irregular reaction increased as the burning rate increased or as the particle size became finer. Owing to propellant processing difficulties, efforts to study the influence of burning rate alone while controlling both oxidizer concentration and particle-size distribution were not successful. It is recommended that the apparent influence of a coarse oxidizer particle-size distribution in suppressing resonance burning be investigated further. (Contractor's abstract)

AER.02:014

Aerojet-General Corp., Azusa, Calif.

SOME EFFECTS OF CHARGE CONFIGURATION IN SOLID PROPELLANT COMBUSTION, by L. Green, Jr. [1958] [3]p. incl. diagrs. table, refs. [AF 18(600)1048] Unclassified

Published in Jet Propulsion, v. 28: 463-465, July 1958.

Static tests were performed employing a high energy, composite solid propellant at 170°F in four different types of charge. As expected, the external-burning rod

AER. 03:004-006; AER. 06:001, 002

grain yielded the most stable reaction. The tubular charge ranked second in reaction stability from both the gross and fine-time-scale viewpoints. Contrary to expectations, the star-perforated charge furnished the most exaggerated examples of resonant burning. The propellant showed significantly different burning characteristics in each configuration. The internal-burning, star perforated, and tubular grains burned more rapidly. The external-burning rod grains appeared to show a higher pressure exponent, and the rod-in-shell charges showed an intermediate value.

AER.03:004

Aerojet-General Corp., Azusa, Calif.

HIGH-FREQUENCY COMBUSTION INSTABILITY, by H. B. Ellis and R. S. Pickford. Sept. 1956 [49]p. incl. illus. diagrs. (Rept. no. TN-17) (AFOSR-TN-56-547) (AF 18(600)1155) AD 110366 Declassified

High-frequency combustion instability is an important problem in thrust-chamber development. Of the various high-frequency combustion-chamber modes, the tangential mode is frequently the most destructive. When encountered, the tangential mode may impose serious delays in thrust-chamber design and development. Investigation of this problem at Aerojet has resulted in the construction of a model of tangential-mode combustion instabilities. The model is discussed from the aspects of the expected behavior of a tangential-front system and the experimental data obtained. The experimental data appear to substantiate the hypothesis presented. (Contractor's abstract)

AER.03:005

Aerojet-General Corp., Azusa, Calif.

BASIC RESEARCH ON COMBUSTION IN LIQUID ROCKET THRUST CHAMBERS, by R. S. Pickford, H. C. Kreig, Jr., and H. B. Ellis. Final technical rept. Jan. 1957, 1v. incl. illus. tables, refs. (Rept. no. 1193) (AFOSR-TR-56-61) (AF 18(600)1155) AD 115015 Declassified

The tangential combustion instability in liquid-propellant rocket motors has been investigated. A physical-process mechanism for fully developed instabilities has been proposed and a system established for the various front modes. The axial and radial distribution of the front occurring in the experimental chamber is discussed. Luminosity, instantaneous pressure, and front motion have been correlated, and an estimate has been made of the movement of chamber gas during unstable combustion. The relative characteristics of three basic injection elements have been investigated by determining the rate of heat transfer from a non-reactive gaseous atmosphere to the injected liquid spray. The effects of gas temperature and pressure, injection orifice diameter,

impingement angle, and relative velocity between the test liquid and the gas are discussed. The investigation was conducted using three test liquids with varying physical properties. (Contractor's abstract)

AER.03:006

Aerojet-General Corp., Azusa, Calif.

THE TANGENTIAL MODE OF COMBUSTION INSTABILITY (Unclassified title), by R. S. Pickford and H. B. Ellis. [1957] 52p. incl. illus. diagrs. (AF 18(600)1155; continued by AF 49(638)178) Confidential

AER.06:001

Aerojet-General Corp., Azusa, Calif.

AN IMPROVED INSTRUMENT FOR THE MEASUREMENT OF LINEAR PYROLYSIS RATES OF SOLIDS, by M. K. Barsh, W. H. Andersen and others. July 15, 1957 [19]p. incl. illus. diagrs. (Rept. no. TN-20) (AFOSR-TN-57-513) (AF 18(600)74; continuation of AF 18(600)-1026) AD 136499 Unclassified

Also published in Rev. Scient. Instruments, v. 29: 392-395, May 1958.

An improved instrument has been designed and constructed for the measurement of the linear decomposition and sublimation rates of solid substances. This instrument, which is provided with automatic recording devices, eliminates many of the shortcomings of the earlier prototypes and makes possible the determination of linear rates with a precision of 1%. Important new features include (1) an integral heating element and thermocouple assembly; (2) stainless-steel and Plexiglas construction throughout; (3) heavy solid-copper electrical conductor supports for the heating element; and (4) a precision position-sensing potentiometer. The use of cut strands of Plexiglas 55 is recommended for periodic standardization and calibration of the instrument. (Contractor's abstract)

AER.06:002

Aerojet-General Corp., Azusa, Calif.

APPLICATION OF SURFACE DECOMPOSITION KINETICS TO DETONATION OF AMMONIUM NITRATE, by W. H. Andersen and R. F. Chalken. June 19, 1958 [10]p. incl. diagr. table, refs. (Rept. no. TN-26) (AFOSR-TN-58-617) (AF 18(603)74) AD 162146 Unclassified

Also published in ARS Jour., v. 29: 49-51, Jan. 1959.

Kinetic rate data for the linear surface gasification (pyrolysis) of ammonium nitrate is used in conjunction

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with the Eyring grain-burning theory to calculate the detonation reaction time for ammonium nitrate. A new grain-burning mechanism is presented which results in a reaction time for detonating ammonium nitrate that is consistent with the one calculated by means of the nozzle and curved-front diameter theories. The implications of the new model with respect to low-velocity detonations in mixtures of granular explosives is discussed. (Contractor's abstract)

AEP.06:003

Aerojet-General Corp., Azusa, Calif.

THE GASIFICATION OF SOLID AMMONIUM NITRATE, by W. H. Andersen, K. W. Bills and others. [1958] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)74; continued by AF 49(638)573 and Wright Air Development Center under AF 33(616)2551) **Unclassified**

Published in Jet Propulsion, v. 28: 831-832, Dec. 1958.

When the surface of solid ammonium nitrate is superheated by a high flux heating technique the ammonium nitrate decomposes in a different manner than the bulk phase liquid.

AER.07:001

Aerojet-General Corp., Azusa, Calif.

USE OF TRANSPORT THEORY IN GAS DYNAMICS PROBLEMS, by S. A. Zwick. May 6, 1957, 8p. (Rept. no. TN-19) (AFOSR-TN-57-686) (Also bound with its TR-57-70; AD 136606 (Confidential)) (AF 18(603)75) **Unclassified**

Beginning with the basic concepts of kinetic theory, a transport equation is obtained for the velocity distribution function of gas particles at ordinary pressures and densities. An expression is given for the time change in a function which measures the deviation of the velocity distribution function from the equilibrium distribution. The advantages of using the linear deviation equation to solve aerodynamic problems are discussed.

AER.07:002

Aerojet-General Corp., Azusa, Calif.

THEORETICAL INVESTIGATION OF HIGH FREQUENCY OSCILLATORY COMBUSTION PHENOMENA IN ROCKET ENGINES (Unclassified title), by S. A. Zwick. Final rept. Apr. 1, 1956-May 31, 1957 [15]p. incl. appendix. (Rept. no. 1303) (AFOSR-TR-57-70) (AF 18(603)75; continued by AF 49(638)252) AD 136606 **Confidential**

AER.08:001

Aerojet-General Corp., Azusa, Calif.

CHEMICAL FRAGMENTS AS ULTRA-ENERGY PROPELLANTS, by W. H. Andersen and G. Moe. July 1957, 32p. incl. refs. (Abstracts Bull. no. 1; rept. no. 1284) (AFOSR-TN-57-408) (AF 18(603)110; continuation of AF 18(600)1216) AD 132486 **Unclassified**

Unclassified literature regarding the research and investigation of highly reactive molecular fragments were abstracted and compiled. The general approach to this literature survey was to abstract pertinent literature and to include abstracts of the most important papers listed only by reference in E. W. R. Steacies (Atomic and Free Radical Reactions, ACS monograph no. 125, 1954). Abstracts of the following journals are presented for the period of 1953 through 1956: (1) Jour. Chem. Phys., 1953 through 1956; (2) Jour. Phys. Chem., 1953 through 1956; (3) Jour. Amer. Chem. Soc., 1956; (4) Jour. Appl. Chem., 1956; (5) Trans. Faraday Soc., 1955 and 1956; (6) Proc. Roy. Soc., 1954 through 1956; (7) Phys. Rev., 1956; (8) Chem. Rev., 1956; and (9) Jour. Inorg. and Nuclear Chem., 1956. The abstracts are grouped within the following categories: (1) production, (2) identification, (3) stabilization, and (4) properties. Within each category, the abstracts are arranged chronologically by year and are numbered consecutively.

AER.08:002

Aerojet-General Corp., Azusa, Calif.

CHEMICAL FRAGMENTS AS ULTRA-ENERGY PROPELLANTS, by W. H. Andersen, J. H. Abraham and others. Oct. 1957, 54p. incl. refs. (Abstracts Bull. no. 2; rept. no. TN-22) (AFOSR-TN-57-699) (AF 18(603)-110) AD 136692 **Unclassified**

The Aerojet-General Corp. is investigating, under sponsorship of the Directorate of Advanced Studies of the Air Force Office of Scientific Research, Air Research and Development Command, certain ultra-energy substances as potential propellants for rocket propulsion. These investigations have necessitated an extensive review of the literature concerned with chemical fragments, embracing the related subjects of production, identification, stabilization, and determination of properties. The ultra-energy substances include charged (ions) and uncharged (free radicals) molecular fragments. This area of research has aroused considerable interest in recent months. Workers in a number of laboratories, both in this country and abroad, are now actively engaged in free-radicals research. As was mentioned in the previous bulletin of this series, it was felt that the information accumulated in the Aerojet-General file of reference abstracts would be interesting and beneficial to other workers in the field. This information should be particularly valuable to those who are only now entering the field. It is the purpose of this bulletin to help make the

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information generally available. (Contractor's abstract)

AER.08:003

Aerojet-General Corp., Azusa, Calif.

RESEARCH ON FREE RADICALS AS ROCKET FUELS (Abstract), by G. Moe. [1957] [2]p. [AF 18(603)110] Unclassified

Published in Program for Symposium on The Formation and Stabilization of Free Radicals, Nat'l. Bur. Standards, Washington, D. C. (Sept. 18-20, 1957), Washington, Nat'l. Bur. Standards, 1957, p. C1-C2.

An analysis has been made of the relationship between the thrust derivable from a rocket and the energy content of the propellant. This analysis indicates that significant increases in the performance of rocket propellants are possible if certain types of free radicals and atoms could be utilized. The atoms and radicals might be introduced into a suitable working fluid, such as hydrogen. The heat of reaction of the radicals would raise the temperature of the working fluid to the desired operating temperature. In this way specific impulse values considerably greater than those obtained from conventional chemical fuels have been calculated. Recent developments in experimental techniques for the production, stabilization, and identification of free radicals and atoms are discussed including a 1000-curie Cobalt-60 gamma ray source which has been designed for irradiation of solids at liquid helium and liquid nitrogen temperatures, and a special low-temperature calorimeter designed to operate in a gamma radiation field, which is capable of measuring heat changes of a few small calories at 77°K. Measurements have been made of the heat generated by radical reactions during the warming of ice samples that have been exposed to approximately 10^7 rep. of Cobalt-60 gamma radiation. On the assumption that the heat generation reaction is the recombination of H and OH, a radical pair concentration of 0.016% was calculated. The temperature range in which the reaction occurs is approximately 95-97°K. Exploratory studies of the production and stabilization of radicals by photo-chemical decomposition of solids at low temperatures indicate that this method is applicable to certain systems. The production of methyl radicals from acetone is suggested.

This report is the third in a series of abstract bulletins reviewing the unclassified literature covering research on highly reactive molecular fragments. It embraces the related subjects of production, identification, stabilization, and determination of properties. It is a comprehensive but not exhaustive bibliography covering work reported in journals from 1954 to 1956.

AER.08:005

Aerojet-General Corp., Azusa, Calif.

A CALORIMETRIC TECHNIQUE FOR THE STUDY OF FREE RADICAL REACTIONS AT LOW TEMPERATURES (Abstract), by J. M. Flournoy. [1958] [1]p. [AF 18(603)-110] Unclassified

Presented at Symposium on Unstable Chemical Species, Los Angeles, Calif., June 23-24, 1958.

A simple calorimetric technique is described for the determination of the amount of energy stored in ice samples after exposure to γ -radiation. Samples of ice weighing about 4 grams are irradiated for periods up to 300 hours in a 1000-curie cobalt-60 source. The maximum dosage rate is about 1.3×10^5 rep/hr, which corresponds to an energy input of about 0.25 calories per hour per gram of sample. The data from four preliminary experiments indicate that somewhat less than 1% of this energy is stored in the ice at 77°K and is released slowly when the temperature of the sample reaches about 106°K. Assuming that the energy release comes from recombination of H and OH radicals, produced by the radiation, the efficiency of radical formation is approximately 10^{11} radical pairs per gram of water per rep, for dosages up to 2×10^6 rep and decreases to about 2×10^{10} r.p./gm-rep after 1.5×10^7 rep. Experiments are in progress to determine more accurately the variation in energy storage with total dosage, the rate of recombination as a function of temperature, and if possible the upper limit of radical concentration attainable with this γ -irradiation technique. An endothermic reaction occurs when the samples are warmed to 120°K, and amounts to about five times as large a heat change as that caused by the exothermic recombination reaction. The possible nature of this process is discussed. (Contractor's abstract)

AER.08:004

Aerojet-General Corp., Azusa, Calif.

CHEMICAL FRAGMENTS AS ULTRA-ENERGY PROPELLANTS, by W. H. Anderson, L. H. Baum, and G. Moe. Mar. 1958, 21p. incl. refs. (Abstracts Bull. no. 3; rept. no. TN-25) (AFOSR-TN-58-223) (AF 18(603)-110) AD 154125 Unclassified

AER.09:001

Aerojet-General Corp., Azusa, Calif.

LITERATURE SURVEY OF THE FLUORINATION OF NITROGEN CONTAINING COMPOUNDS (Unclassified title), by N. W. Thomas. Apr. 12, 1957, 50p. incl. refs. (Special rept. no. 1242) (AFOSR-TN-57-548) (AF 49-(638)25) AD 136582 Confidential

AER. 10:001; AER. 11:001, 002

AER.10:001

Aerojet-General Corp., Azusa, Calif.

INTERACTION OF BURNING LIQUID DROPLETS AND SHOCK WAVES, by K. Sato. Final rept. Mar. 1, 1957-Mar. 31, 1958. Aug. 27, 1958, 1v. incl. illus. diagrs. table. (AFOSR-TR-58-119) (AF 49(638)82) AD 202909 Unclassified

Experiments were performed to determine the interaction of shock waves on liquid droplets and were recorded by means of high-speed photography. Photographic evidence obtained has shown clearly that the viscous drag of the gas flow behind the shock, and not the shock front itself, is responsible for droplet breakup. The results obtained have indicated that the range of shock strengths used in this program (Mach 1.08 to 2.55) has resulted in the shear mode of droplet disintegration. Also, the degree of dispersion of liquid droplets in the burning cases was considerably greater than that in the non-burning, apparently because of deviations from spherical shapes resulting in higher drag forces. When the injected fluid forms non-spherical droplets, useful comparison of breakup with shock strengths cannot be made, because a parameter which describes deviation of droplets from spheres is needed before correlations can be made. In order to establish this parameter, secondary atomization should be considered as a mode for droplet breakup of the injected propellants. This could result in droplets which are much smaller than those obtained without secondary atomization, and could be the controlling factor in the combustion process. Therefore, it would be necessary to evaluate breakup at these droplet sizes in order to permit correlation of experiments conducted in a shock tube with the phenomena occurring in a rocket combustion chamber. The evaluation of the critical flow velocity, which will result in droplet breakup, will be a function of droplet configuration (that is, deviation from spherical shape) as well as other physical properties of the droplet. Therefore, further studies will be required on the behavior of propellant droplets under conditions simulating as closely as possible those existing in rocket chambers before a definite atomization criteria can be achieved.

AER.11:001

Aerojet-General Corp., Azusa, Calif.

A THEORETICAL STUDY OF THE RECOMBINATION KINETICS OF ATOMIC OXYGEN, by S. T. Demetriades and M. Farber. Nov. 8, 1957, 1v. incl. diagrs. tables, refs. (Rept. no. TN-21) (AFOSR-TN-58-18) (AF 49-638)111 AD 148057; PB 136998 Unclassified

Presented at 133rd meeting of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Also published in ARS Jour., v. 29: 528-530, July 1959.

Favorable conditions are determined for the study of the recombination kinetics of atomic oxygen. A rate constant for the oxygen-recombination mechanism,

$O + O + M \rightarrow O_2 + M$, of the order of 10^{15} to 10^{16} cc²/mol²-sec, depending on the temperature, has been derived theoretically. For a recombination rate of this magnitude, static experiments can be performed in the range of temperatures from 1500 to 2000°K and pressures

of the order of 10^{-3} atm, provided that the wall recombination is not faster than predicted by the rate of collisions of colliding oxygen atoms with the wall. The present estimate of the rate of oxygen recombination is compared with previous estimates and with the rate of oxygen-molecule production due to wall recombination and to the ozone-recombination mechanism, $O_3 + O \rightarrow 2O_2$.

If the recombination-rate constant for the three-body homogeneous process is below 2×10^{15} cc²/mol²-sec or the wall recombination is a first-order process, dynamic experiments would be required to eliminate wall effects. (Contractor's abstract)

AER.11:002

Aerojet-General Corp., Azusa, Calif.

THE USE OF PLANETARY ATMOSPHERES FOR PROPULSION, by S. T. Demetriades and C. B. Kretschmer. Apr. 1958 [18]p. incl. tables. (Rept. no. TN-24) (AFOSR-TN-58-229) (AF 49(638)111) AD 154132 Unclassified

Also published in Fourth annual meeting of the Amer. Astronaut. Soc., New York (Jan. 29-31, 1958), N. Y., Amer. Astronaut. Soc., 1958, p. 46-1 - 46-14.

Reaction kinetics of atomic oxygen in the earth's upper atmosphere is presented, and a preliminary analysis is made of an atomic-oxygen propulsion unit. Estimates of the mechanism and magnitude of the recombination rates for atomic oxygen are presented in the homogeneous phase as well as in the heterogeneous phase (i.e., on a catalytic surface). These estimates are based on the results of collision-rate theory, absolute reaction-rate theory, and the interpretation of experimental data available in the literature on other 3-body recombination reactions and surface-recombination reactions. Assuming 100% efficiency in utilizing the atomic-oxygen

recombination energy, a thrust of 40 dynes per cm² of inlet area is obtained at 100 km altitude. This thrust is independent of the flight speed and depends on the altitude only; and it compares favorably with the expected drag at those altitudes at low flight speeds. The ideal thrust-to-minimum-drag ratio is generalized for any recombination power plant in any planetary atmosphere; and it is shown that as a first approximation, this ratio is independent of altitude and absolute concentrations. (Contractor's abstract)

AER.11:003 - AER.11:006

AER.11:003

Aerojet-General Corp., Azusa, Calif.

THE UTILIZATION OF ATOMIC OXYGEN RECOMBINATION IN THE EXOSPHERE (SIGNIFICANCE OF FINDINGS), by S. T. Demetriades, C. B. Kretschmer, and M. Farber. Mar. 18, 1958, 5p. (AFOSR-TN-58-262) (AF 49(638)111) Unclassified

The possibility of utilizing the atomic oxygen and atomic nitrogen present in the upper atmosphere for propulsion purposes is discussed. At high altitude 30% by volume or 20% by weight of the available oxygen is dissociated offering an inexhaustible supply of energy for propulsion and other purposes. An experimental program involving the study of atomic oxygen recombination rates is described.

AER.11:004

Aerojet-General Corp., Azusa, Calif.

A PRELIMINARY INVESTIGATION OF AN ATOMIC-OXYGEN POWER PLANT, by S. T. Demetriades and C. B. Kretschmer. Mar. 4, 1958, 30p. diagrs. tables, refs. (Rept. no. TN-23) (AFOSR-TN-58-325) (AF 49(638)111) AD 154229; PB 137008 Unclassified

Assuming 100% efficiency in utilizing the atomic-O recombination energy, a thrust of 5.7×10^{-4} lbf/sq in. of inlet area was obtained at an altitude of 100 km. Theoretical estimates indicated that the recombination of atomic O can be effected in a continuous-flow (open cycle) power plant by ram-compression alone, without a catalyst. Thrusts of the order of 5.7×10^{-5} lbf/sq in. of inlet area were achieved with power-plant lengths less than 1000 ft, at flight speeds of about 11,000 fps ($M = 10$) and altitudes of about 100 km. These thrusts compared favorably with the minimum frictional drag expected at those altitudes at low flight speeds, but were not sufficient to sustain flight at orbital speeds. At 100 km, the thrust of a ramjet power plant, in which 50% of the atomic O was recombined and 36% of the energy of recombination was lost due to internal losses, is only 13 dynes/sq cm of inlet. At orbital speed at that altitude, the minimum frictional drag was about 13 dynes/sq cm of the outer surfaces. A purely catalytic atomic-O power plant will require an effective length several times greater than the inlet radius and therefore cannot fly at orbital speeds. Flight of an atomic-O ramjet at orbital speeds only becomes feasible if the drag can be reduced by a factor of 10 or more and if the total recombination rate can be increased by a factor of 10 or more.

AER.11:005

Aerojet-General Corp., Azusa, Calif.

UTILIZATION OF ATOMIC OXYGEN RECOMBINATION IN THE UPPER ATMOSPHERE (Abstract), by S. T. Demetriades, C. B. Kretschmer, and M. Farber. [1958] [1]p. [AF 49(638)111] Unclassified

Presented at meeting of the Petroleum Div. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Published in 133rd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 5-Q.

In the upper atmosphere at 100 km there is approximately 10^{-6} cal per cc of available energy in the form of atomic oxygen. This offers an inexhaustible supply of energy for propulsion and other purposes. The rational design of an atomic-oxygen power plant requires knowledge of the efficiency of conversion of this available energy. This efficiency depends primarily on the recombination rate of atomic oxygen. This paper presents the reaction kinetics of atomic oxygen in the upper atmosphere and a preliminary analysis of an atomic-oxygen propulsion unit. Estimates are presented of the mechanism and magnitude of the recombination rates for atomic oxygen in the homogeneous phase as well as of the recombination rates in a heterogeneous system - that is, on a catalytic surface. These estimates are based on the results of collision rate theory, absolute reaction rate theory, and the interpretation of experimental data available in the literature on other three-body recombination reactions and surface-recombination reactions. Assuming 100% efficiency in utilizing the atomic-oxygen recombination energy, a thrust of 40 dynes per sq cm of inlet area is obtained. This thrust is independent of the flight speed and depends on the altitude only and it compares favorably with the expected drag at those altitudes at low flight speeds.

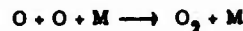
AER.11:006

Aerojet-General Corp., Azusa, Calif.

ATOMIC OXYGEN RECOMBINATION RATES (Abstract), by C. B. Kretschmer. [1958] [1]p. (AF 49(638)111) Unclassified

Presented at Symposium on Unstable Chemical Species, Los Angeles, Calif., June 23-24, 1958.

The rate constant for recombination of oxygen atoms by the three-body mechanism:



is known from shock tube experiments to lie in the range $10^{15} - 10^{17}$ cm⁶/mole² at temperatures in the neighborhood of 3000°K. No measurements of this rate

AIR FORCE SCIENTIFIC RESEARCH

AER.12:001, 002; AER.13:001;
ANS.01:003, 004

constant at lower temperatures or by other experimental methods have been reported. By an application of Eyring's theoretical treatment, the following estimate has been obtained: $k_1 = 3 \times 10^{16} (300/T)^{1.5}$. Since some of the shock-tube measurements on air have been interpreted as implying rates of recombination greater than the rate of pertinent three-body collisions, it has been conjectured that recombination in air occurs by a chain mechanism involving nitric oxide. The possibility of such a chain mechanism is discussed. Finally, the present outlook for utilization of the atomic oxygen content of the upper atmosphere as a source of energy for propulsion is reviewed.

AER.12:001

Aerojet-General Corp., Azusa, Calif.

HIGH FREQUENCY INSTABILITIES AND SCALING IN ROCKET ENGINES, by N. Thomas. July 31, 1958 [24]p. incl. diagrs. (Rept. no. TN-27) (AFOSR-TN-58-1026) (AF 49(638)178; continuation of AF 18(600)1155) AD 162293 Declassified

An analysis is made of the high-frequency instabilities occurring in rocket engines in terms of a postulated energy coupling between acoustic-frequency oscillations and the combustion process. An energy criterion for stability is derived and applied to the problem of scaling rocket engines against instabilities. (Contractor's abstract)

AER.12:002

Aerojet-General Corp., Azusa, Calif.

COMBUSTION STABILITY CORRELATION BETWEEN LABORATORY PULSE MOTOR AND 50,000 TO 150,000-POUND-THRUST-LEVEL FIRINGS, by H. C. Krieg, Jr. June 27, 1958 [10]p. incl. diagrs. [AF 49(638)178] Declassified

All known cases of pulse-motor firings simulating tested full-scale injectors are presented in this report. These have been few in number. The full-scale stability results agree in every case with those indicated by the results of the stability-pulse-motor tests. These data show that the stability pulse motor is capable of reliable prediction of the resistance to combustion instability of patterns under consideration for full-scale testing. (Contracted from rept.)

AER.13:001

Aerojet-General Corp., Azusa, Calif.

ION SOURCES (Abstract), by R. J. Sunderland. [1958] [1]p. (AF 49(638)214) Unclassified

Presented at Symposium on Unstable Chemical Species, Los Angeles, Calif., June 23-24, 1958.

Ionically propelled space vehicles will require total ion currents ranging from several hundred to several thousand amperes. The source of these ions must be capable of continuous operation for periods extending to several earth years. Such a source would be composed of a large number of modular units each having high ion current densities, high ion efficiencies, and high ion-to-neutral-particle ratios. Ideally, the unit must be flexible enough to allow the current to be varied over a wide range, and light enough so that the complete source contributes only insignificantly to the total mass of the power plant. Existing ion sources vary in their degree of applicability from poor to favorable, and a number of sources now under study may eventually provide the necessary copious ion beams.

ANL01:003

Aeromutronic Systems, Inc., Glendale, Calif.

VEHICLE FINAL DESIGN AND PROJECT STATUS REPORT, VOL. I, PROJECT FAR SIDE (Unclassified title). Jan. 30, 1957, iv. incl. illus. diagrs. tables. (Rept. no. C-028) (AFOSR-TN-57-42) (AF 49(638)55) AD 312947 Confidential

ANS.01:004

[Aeromutronic Systems, Inc., Glendale, Calif.]

MINNEAPOLIS TEST REPORT "PROJECT FAR SIDE," by C. P. Merrell and P. A. Pankow. July 19, 1957, 7p. illus. diagrs. table. (In cooperation with General Mills, Inc., Minneapolis, Minn.) [AF 49(638)55] Declassified

This is a report on "Project Far Side," a test held at General Mills Flight Center, Minneapolis, Minn. on June 28, 1957 for the purpose of providing information to be used in later operational flights. The flight proved beyond doubt the ruggedness of the balloon, the reliability and strength of all mechanical components, the practicability and feasibility of the balloon and load launching system, the alignment of the load and balloon system, and it also established a new record for balloon volume. The ability of the 212-1-1 balloon to withstand shock and carry heavy loads was undoubtedly proved. The "Far Side" suspension system performed all of the tasks which could be tested with a dummy rocket. No member appeared to be overly stressed or weakened. Three recommendations for improvements are as follows: (1) a cable holdback should be designed for the suspension arm in place of nylon; (2) the instrument bag attachment point should be lowered to the midpoint of the cage; and (3) the support method should be changed in the upper ring (nylon or styrofoam).

AIR FORCE SCIENTIFIC RESEARCH

ANS.01:005-007; AIR.01:001-003

ANS.01:005

Aeronutronic Systems, Inc., Glendale, Calif.

A REPORT CONCERNING FAR SIDE PHASE II PRE-LIMINARY STUDIES (Unclassified title), (n.a.) May 27, 1957, 1v. incl. illus. diagrs. tables. (Rept. no. S-082) (AFOSR-TN-58-853) (AF 49(638)55) AD 312945
Secret

ANS.01:006

Aeronutronic Systems, Inc., Glendale, Calif.

PROJECT FAR SIDE PHASE I: VOL. I OF II (Unclassified title). Final rept. Jan. 15, 1958, 174p. incl. illus. diagrs. tables. (Rept. no. C-125) (AFOSR-TR-58-45, v. 1) (AF 49(638)55) AD 312948
Confidential

ANS.01:007

Aeronutronic Systems, Inc., Glendale, Calif.

PROJECT FAR SIDE PHASE I: VOL. II OF II. Final rept. Jan. 15, 1958 [85p. incl. diagrs. tables. (Rept. no. C-125) (AFOSR-TR-58-45, v. 2) (AF 49(638)55) AD 227315
Unclassified

On the basis of the limited amount of vehicle performance data that were obtained in six attempted flights, it is possible that Flights 2, 5 and 6 performed properly and reached altitudes of 3,000 - 4,000 miles. Unfortunately, the lack of adequate ground instrumentation and the loss of telemetry signal preclude positive proof of this. It has not been possible to establish positively whether the telemetry fadeout was due to some peculiar propagation phenomenon (for example, the very intense electron densities reported by Van Allen at altitudes of 600 - 1800 miles), reentry, or component failure. However, since the optical tracking data, particularly in Flights 5 and 6, indicate good performance through second stage burning (which unfortunately was the maximum range of the optical system) and the telemetry data during these periods are either missing or somewhat confusing, an interpretation of performance based primarily on the limited telemetry data would seem questionable.

Aerophysics Development Corp. see Curtiss Wright Corp.
Aerophysics Development Div., Santa Barbara, Calif.

AGARD, Paris (France). (Advisory Group for Aeronautical Research and Development) see North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, Paris (France).

AIR.01:001

Air Force Office of Scientific Research, Washington, D. C.

VISTAS IN ASTRONAUTICS, VOLUME I. PROCEEDINGS OF THE FIRST ANNUAL AIR FORCE OFFICE OF SCIENTIFIC RESEARCH ASTRONAUTICS SYMPOSIUM, San Diego, Calif. (Feb. 19-20, 1957), ed. by M. Alperin, M. Stern, and H. Wooster. N. Y., Pergamon Press, 1958, 330p. incl. illus. diagrs. tables, refs. (Internat'l. Series of Monographs on Aeronaut. Sciences and Space Flight) (AFOSR-TR-57-14) (Sponsored jointly by Air Force Office of Scientific Research and General Dynamics Corp., Convair Div., Pomona, Calif.)
Unclassified

The 2 main objectives of the symposium were (1) to survey the scientific and technological progress of astronautics and (2) to indicate the lines of research needing emphasis to facilitate future space exploration. This volume contains the 40 papers presented and a subject index. The general areas included are: (1) re-entry, (2) tracking and communications, (3) environment and measurements, (4) propulsion, (5) orbits, and (6) human factors.

AIR.01:002

Air Force Office of Scientific Research, Washington, D. C.

ASTRONAUTICS SYMPOSIUM; SUMMARY SESSION, San Diego, Calif. Feb. 19, 1957, 55p. (AFOSR-TR-57-14a) (Sponsored jointly by Air Force Office of Scientific Research and General Dynamics Corp., Convair Div., Pomona, Calif.) AD 120430
Unclassified

This report is the transcript of a tape recording made during the summary session of the First Annual Air Force Office of Scientific Research Astronautics Symposium, San Diego, Calif., Feb. 18-20, 1957. The 6 panel leaders summarized the papers presented at the following panel discussions: (1) re-entry, (2) tracking and communications, (3) environment and measurements, (4) propulsion, (5) orbits, and (6) human factors. Additional comments are included as well as a list of the participants.

AIR.01:003

Air Force Office of Scientific Research, Washington, D. C.

PROGRESS IN AIR FORCE SCIENTIFIC RESEARCH, by H. F. Gregory. [1957] [3p. incl. illus.]
Unclassified

Published in Missiles and Rockets, v. 2: 105-109, July 1957.

The mission of the Air Force Office of Scientific Research, an agency of the Air Research and Development

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AIR.01:004 - AIR.01:008

Command, is the encouragement of exploratory effort, the understanding of its results and utilization of its findings for the present and future needs of the Air Force. Their method of operation includes making missions known to research sources, examining their lines of investigation and providing whatever support and guidance they may need. To accomplish this, AFOSR seeks help from its academic and industrial laboratories. AFOSR with its military and civilian personnel are charged with the sole task of recognizing the military implications of this work and supporting with funds, tools, procurement methods and communications, those persons who can supply the essential ingredients for certain given tasks. Some of the work and progress made by AFOSR is presented in this paper.

AIR.01:004

Air Force Office of Scientific Research, Washington, D. C.

A NEW LOOK AT AVIATION PHYSIOLOGY, by H. E. Savely and J. P. Henry. [1957] [4]p. Unclassified

Presented at Twenty-eighth annual meeting of the Aero Med. Assoc., Denver, Colo., May 8, 1957.

Published in Jour. Aviation Med., v. 28: 531-534, Dec. 1957.

This paper points to the need for more emphasis on the study of the nervous system in aviation physiology and for a closer alignment with psychology. The critical problem areas which need to be studied more intensively include the phenomena of sleep, wakefulness, attention, emotional arousal, perception, discrimination, learning, motivation, and drive.

AIR.01:005

Air Force Office of Scientific Research, Washington, D. C.

AEROTHERMOELASTICITY, by M. Rogers. [1958] [11]p. incl. diagrs. table, refs. (AFOSR-TN-58-500) AD 158310 Unclassified

Also published in Aero/Space Engineering, v. 17: 34-44, Oct. 1958.

The present method of handling aerothermoelastic problems is to divide the general problem into two separate problems-the athermal and the aeroelastic-such of which can be handled, to a large degree, by methods already available to the structural engineer. This division rests on assumptions which may not always be valid under high-temperature flight environments. Research is needed to clarify the strength of the interactions between heat input and aeroelastic phenomena, other than the well-known reductions in moduli of elasticity of the structural materials and the introduction of thermal stresses. The general problem of aerothermoelasticity

is too complex to be successfully approached by analytical means alone. New and unique experimental facilities are needed for aerothermoelastic research before significant progress can be made. Model tests are useful in developing optimum theories. Complete simulation in the laboratory of all the elastic, inertial, and unsteady aerodynamics and of heat-transfer properties of a prototype is virtually out of the question, except for geometric scale ratios of nearly one. Thus, "restricted purpose" models must be employed. (ASTIA abstract)

AIR.01:006

Air Force Office of Scientific Research, Washington, D. C.

SECOND ANNUAL REPORT, AFOSR, 1957. July 1958, 222p. (AFOSR-TR-58-71) AD 158300 Unclassified

This report covers the accomplishments of the exploratory research program supported by the Air Force Office of Scientific Research (ARDC) during 1957. It is in three parts: I - The Commander's Summary, reviewing the year's highlights; II - Text, giving in more detail the results of the contract research program monitored by the Directorates, Advanced Studies, Aeronautical Sciences, Bio-Sciences, Material Sciences, and Research Communication, and their Technical Divisions, Aeromedicine, Behavioral Sciences, Chemistry, Combustion Dynamics, Mathematics, Mechanics, Nuclear Physics, Physics, and Solid State Sciences; III - An appendix listing AFOSR consultants and research contractors, indexed by contractor and investigator.

AIR.01:007

Air Force Office of Scientific Research, Washington, D. C.

PROCEEDINGS OF THE FLIGHT FLUTTER TESTING SYMPOSIUM (Unclassified title), May 15-16, 1958. Dept. of Commerce Auditorium, Washington, D. C., 196p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-114) (Sponsored jointly by Aircraft Industries Assoc., and Air Force Office of Scientific Research under Project no. P9783/737728) AD 301611 Confidential

AIR.01:008

Air Force Office of Scientific Research, Washington, D. C.

CONFERENCE ON ION AND PLASMA RESEARCH, Maryland U., College Park, Sept. 30-Oct. 2, 1958. [1958] 1v. incl. refs. (AFOSR-TR-58-125) AD 162274 Unclassified

This report contains 54 abstracts of papers presented at the conference. The general areas discussed include: (1) the theory of plasmas and plasmoids; (2) plasma jets, production, and acceleration; (3) ionized plasmas;

AIR. 01:009; ALA. 01:001-004

(4) magnetohydrodynamics; (5) hydromagnetic wave motion; (6) shock; (7) noise in gas discharges; (8) outer-space effects on electron and ion beams; (9) high-altitude voltage; (10) statistical mechanics of many-body systems; (11) heat transfer; and (12) ion rocket design.

AIR.01:009

Air Force Office of Scientific Research, Washington, D. C.

SYMPOSIUM ON UNSTABLE CHEMICAL SPECIES.
ABSTRACTS OF PAPERS, Los Angeles, Calif., June 23-24, 1958. [18]p. Unclassified

Sixteen abstracts are presented on the subject of unstable chemical species. Various methods are discussed for the production, detection, and stabilization of free radicals in the solid and gaseous states.

ALA.01:001

Alabama Polytechnic Inst. Auburn Research Foundation, Inc., Auburn.

CAUCHY PROBLEM FOR THE DAMPED WAVE EQUATION WITH POLYHARMONIC INITIAL CONDITIONS, by E. P. Miles, Jr. and E. Williams. [1957] 7p. (In cooperation with Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park) (AF 49(638)81) Unclassified

Also published in Portugal. Math., v. 17: 53-57, 1958.

A recent method for solving the Cauchy problem for a certain class of linear partial differential equations with initial data of a restricted type is applied to the damped wave equation with polyharmonic initial conditions.

ALA.01:002

Alabama Polytechnic Inst. Auburn Research Foundation [Inc.] Auburn.

THE ANALYTIC CAUCHY PROBLEM FOR THE ITERATED WAVE EQUATION, by E. P. Miles, Jr. Apr. 1958 [13]p. (Technical note no. BN-133) (AFOSR-TN-58-340) (In cooperation with Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park) (AF 49(638)81) AD 154245 Unclassified

Presented at meeting of the Amer. Math. Soc., New York, Aug 26, 1958.

Also published in Portugal. Math., v. 18: 111-119, 1959.

A basic set of polynomial solutions for the iterated wave equation is developed from which an explicit closed form

solution of the associated Cauchy problem with polynomial data is obtained. The corresponding problem with polyharmonic and analytic data is discussed. This problem has been solved in the case of more general data, but the present method gives simple closed form solutions in many cases where the multiple integrals involved in the other solutions would be difficult to evaluate. An example is given in which a singularity of the data is not propagated into the solution on the characteristic surface leading from the singular point. (Contractor's abstract, modified)

ALA.01:003

Alabama Polytechnic Inst. Auburn Research Foundation [Inc.] Auburn.

ON CERTAIN REFLECTION PRINCIPLES, by E. P. Miles, Jr. July 1958 [10]p. incl. refs. (Technical note no. BN-146) (AFOSR-TN-58-702) (In cooperation with Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park) (AF 49(638)81) AD 162236 Unclassified

The classical reflection principle for harmonic functions due to Schwarz has been generalized for biharmonic functions by Poritsky and Duffin and for polyharmonic functions by Huber. If a polyharmonic function of order p , which is such, that the function and its first $p-1$ derivatives vanish on the hyperplane of reflection, has an analytic continuation across this hyperplane, then a locally valid expansion for the function is obtained in terms of the Cauchy data on the hyperplane. From this expansion an alternate reflection principle of limited range is obtained which is shown to be reducible to the Schwarz, Duffin, and Huber principles for $p = 1, 2, 3$, respectively, within their common range of validity. A brief description is also presented of a corresponding heuristic approach to the reflection principle for the Helmholtz equation.

ALA.01:004

Alabama Polytechnic Inst. Auburn Research Foundation, Inc., Auburn.

BASIC SETS OF POLYNOMIALS FOR THE ITERATED LAPLACE AND WAVE EQUATIONS, by E. P. Miles, Jr. and E. Williams. [Jan. 1958] 8p. refs. (In cooperation with Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park) (AF 49(638)81) Unclassified

Also published in Duke Math. Jour., v. 28: 35-40, Mar. 1959.

For each pair of integers, $n \geq 0$ and $m > 0$, and the associated sets of non-negative integers a_1, a_2, \dots, a_k

ALF.02:001 - ALF.02:004

such that $a_k \geq 2m-1$ and $\sum_{j=1}^k a_j = n$, the set of homogeneous polynomials

$$P_{a_1}^n = \sum_{j=0}^{n-a_k/2} (-1)^j \left[\frac{j+[a_k/2]}{[a_k/2]} \right] \nabla^{2j} \left(\frac{k-1}{\prod_{i=1}^k a_i} \right) \cdot \frac{x_k^{a_k+2j}}{(a_k+2j)!}$$

is shown to form a basic set of k variable polyharmonic polynomials of order m (i.e., solutions of $\nabla^{2m} u = 0$).

Deletion of the factor $(-1)^j$ gives an analogous basic set for the iterated wave equation

$$\left(\sum_{j=1}^{k-1} \frac{\partial^2}{\partial x_j^2} - \frac{\partial^2}{\partial x_k^2} \right)^m u = 0.$$

The paper concludes with the expansion of an arbitrary polynomial in terms of the basic set. (Contractor's abstract)

ALF.02:001

Alfred U. New York State Coll. of Ceramics, N. Y.

IONIC CONDUCTIVITY AND DIFFUSION IN ALKALI HALIDES, by E. A. Giess. A Review. Sept. 1957, 62p. incl. diagrs. tables, refs. (AFOSR-TN-57-814) (AF 18(600)1448) AD 136604 Unclassified

A general review is presented of the theory of ionic conduction and diffusion processes in alkali halides, especially as related to the defect solid state. Consideration was given to (1) the theory of densities of vacancies and their heats of formation, (2) the simple diffusion theory, (3) the simple ionic conduction theory, (4) the Nernst-Einstein relation, (5) the correlation effect, (6) the intrinsic ionic conduction, and (7) the extrinsic ionic conduction. The review does not cover the field of dielectric loss measurements which has produced much useful information. The extensive field of color centers and related optical phenomena were also omitted. Although the theory is considered to be in an advanced stage, there are still several aspects of the subject which have not been satisfactorily explained. The role played by the crystal substructure and surface in these processes, the exact cause of the polarization phenomena, and the explanation for the observed deformation and cold-working effects are some of the unsolved problems. (ASTIA abstract)

ALF.02:002

Alfred U. New York State Coll. of Ceramics, N. Y.

SYMPOSIUM ON THE DEFECT SOLID STATE - DIFFUSION IN IONIC SOLIDS, by T. J. Gray, B. D. James, and E. A. Giess. Second annual rept. Sept. 1957, 105p. incl. diagrs. tables, refs. (AFOSR-TN-57-

615) (AF 18(600)1448) AD 154871 Unclassified

A quantitative theory has been given for contribution to ionic conductivity of frozen-in vacancies and, using experimental data, it has been estimated that such an effect could be observed in very pure sodium chloride crystals. Furthermore, a rough theoretical approach to vacancy-formation kinetics has been suggested and some experimental evidence for its validity has been cited. (Contractor's abstract)

ALF.02:003

Alfred U. New York State Coll. of Ceramics, N. Y.

DIFFUSION AND CONDUCTION IN IONIC SOLIDS, by E. A. Giess. June 1958, 1v. incl. diagrs. tables, refs. (AFOSR-TN-58-910) (AF 18(600)1448) AD 202408 Unclassified

The extrinsic (low-temperature) conductivity of NaCl was studied, with particular attention being given to the differences in conductivity between solution-grown and melt-grown crystals. The principal effect which was observed was an increase in the extrinsic conductivity of the solution-grown crystals after they had been heated to high temperatures in the intrinsic range; this effect was not observed in melt-grown crystals. A review of literature and general theory is presented on the theory of vacancies and their heats of formation, simple diffusion theory, simple ionic conduction theory, Nernst-Einstein relation, the correlation effect to explain the low-temperature failure of the Nernst-Einstein relation, and intrinsic and extrinsic ionic conduction.

ALF.02:004

Alfred U. New York State Coll. of Ceramics, N. Y.

CERTAIN ASPECTS OF DIFFUSION AND CONDUCTION IN ALKALI HALIDES, by E. A. Giess and T. J. Gray. [1958] 7p. incl. refs. (AFOSR-TN-58-911) (AF 18(600)-1448) AD 204589 Unclassified

Also published in Conf. on the Kinetics of High-Temperature Processes, Massachusetts Inst. of Tech., Cambridge (June 23-27, 1958), Cambridge, Technology Press, 1958, p. 11-13.

A dc pulse technique has been used to measure the ionic conductivity of NaCl crystals of low level Pb and Mg impurity content which have been grown from solution. The low temperature conductivity has been found to be irreversibly connected to the extrinsic conductivity and is explained by a tendency of the crystal vacancies to congregate at dislocations and other mosaic surfaces. A $PbCl_2$ coordination complex is believed to exist in the Pb impurity samples after annealing in the intrinsic region.

ALF.03:001

ALF.03:001

Alfred U. New York State Coll. of Ceramics, N. Y.

THE ELECTRICAL RESISTIVITY OF SINGLE-CRYSTAL ALUMINA OVER THE TEMPERATURE RANGE 1000°-1500°C, by L. E. Sobon. May 12, 1957, 11p. incl. diagrs. refs. (AF 49(638)87) Unclassified

The electrical resistances of two samples of single-crystal sapphires was measured over a temperature range of 1000° to 1500°C. A furnace and sample holders were designed, and a unique method for measuring resistivity was used. This method does not require an external power supply in the measuring circuit. The geometry of the circuit is such that current leakage between sample holder has no effect on the measurements.

ALF.03:002

Alfred U. New York State Coll. of Ceramics, N. Y.

SOME OBSERVATIONS OF THE DIELECTRIC PROPERTIES OF Al_2O_3 , by H. C. Graham. July 1957, 41p. incl. diagrs. tables, refs. (AF 49(638)87) Unclassified

The purposes of this investigation were to (1) determine some of the fundamental dielectric values, i.e., capacitance and dielectric loss of alumina as a function of temperature and frequency, and (2) to develop a measuring apparatus capable of obtaining reproducible results over the temperature and frequency range of -200 to 500°C and 10^2 to 10^5 c/s, respectively. The values of capacitance reported are relative as no attempt was made to obtain absolute values. The samples measured were single crystal corundum and polycrystalline pressed alumina. In both cases they were made from Linde gamma alumina "high purity" powder (Linde Air Products Company). The values of capacitance and dielectric loss are given for all points; the dielectric constant is calculated at room temperature and 10^3 c/s for the single crystal measured both perpendicular to and parallel to the optic axis; the effective dc resistance for the single crystal is compared with previous work on resistivity of Al_2O_3 ; an activation energy is calculated for one of the peaks observed on the single crystal measured perpendicular to the optic axis; and a brief analysis of all the peaks observed is presented.

ALF.03:003

Alfred U. New York State Coll. of Ceramics, N. Y.

SOME OBSERVATIONS OF THE DIELECTRIC LOSS IN Al_2O_3 (Abstract), by H. C. Graham, N. M. Tallan, and D. P. Detwiler. [1958] [1]p. (AF 49(638)87) Unclassified

Presented at meeting of the Amer. Ceramic Soc., Washington, D. C., Apr. 26-May 1, 1958.

Published in Bull. Amer. Ceramic Soc., v. 37: 31, Apr. 1958.

The dielectric loss and dielectric constant of single crystal and polycrystalline alumina were measured between temperatures of -200 and +500°C and between frequencies of 10^2 and 10^5 cps. Single crystals of alpha alumina prepared by the Verneuil process, containing traces of several impurities, were measured both perpendicular to and parallel to the optic axis and $\tan \delta$ values are presented. Several indications of Debye-type loss maxima were observed and an activation energy of approximately 10 ev is calculated for one of these. The effective dc resistance of the single crystal found by extrapolation of the loss curve to higher temperatures is compared with values of the resistance previously found in these laboratories by direct measurement at elevated temperatures. Polycrystalline samples pressed from the gamma alumina powder used as raw material for the flame-fusion crystal preparation were sintered at temperatures between 955°C and 1400°C. Measurements of the dielectric loss for these samples revealed the disappearance of loss maxima after the polymorphic inversion from gamma alumina to alpha alumina and the presence of significant conduction loss in polycrystalline samples at temperatures lower than those found for single crystal samples. The activation energy associated with the loss maxima found in gamma alumina was calculated to be approximately 1 ev.

ARA.01:001

Allied Research Associates, Inc., Boston, Mass.

THE HEATING OF SLABS WITH ARBITRARY HEAT INPUTS, by T. R. Goodman. May 28, 1958, 17p. (AFOSR-TN-58-524) (AF 49(638)347) AD 158337; PB 135560 Unclassified

Also published in Jour. Astro/Space Sciences, v. 26: 187-188, Mar. 1959.

This method of heat balance integral [T. R. Goodman, Trans. Amer. Soc. Mech. Engrs., v. 80: 335, 1958] with a cubic profile has been applied to predict the surface temperatures of slabs when the heat flux at the surface is an arbitrary function of temperature and time. The method has been extended to the case of thermally dependent transport properties. The technique always reduces the problem to the solution of a first order ordinary differential equation which can frequently be solved by quadratures. In all cases, however, the resulting ordinary differential equation is far simpler to solve than the partial differential equation of heat conduction. The method will be particularly useful when the data is given empirically, as, for example, in the case of a missile trajectory when the external conditions

ARA.01:002, 003; AIP.01:001;
AMF.02:003; AMS.03:001

such as speed, air temperature and air density vary with time. (Contractor's abstract)

ARA.01:002

Allied Research Associates, Inc., Boston, Mass.

THE ABLATION OF MELTING BODIES WITH HEAT PENETRATION INTO THE SOLID, by T. R. Goodman. Aug. 1, 1958, 20p. incl. diagrs. (AFOSR-TN-58-789) (AF 49(638)347) AD 202115; PB 136753 Unclassified

The equation describing the ablation of melting bodies was described by the author previously (Aerodynamic Ablation of Melting Bodies. Third U. S. Congress of Appl. Mech., Brown U., June 1958). For this equation, assumptions were made that once the melting of the surface started, all the heat flux was used in producing molten material, and none of the heat penetrated beyond the melt line into the solid. Distribution of the heat flux along the surface was assumed to be uniform. Now, both restrictions are removed, and heat is allowed to diffuse into the solid as well as to produce melt. The heat flux is distributed according to the laminar boundary-layer theory. The results are worked out in detail for a flat plate. As a consequence of allowing heat diffusion into the solid, there are now 2 concurrent phenomena, for each of which there is an associated rate: (1) the rate of heat diffusion into the solid, and (2) the rate at which a quasi-steady-state ablation process is established. For purposes of computing the rate at which molten material is ablated from a body, the simple quasi-steady theory is adequate except at very early time. (Contractor's abstract)

ARA.01:003

Allied Research Associates, Inc., Boston, Mass.

THE MELTING OF FINITE SLABS, by T. R. Goodman and J. J. Shea. Aug. 15, 1958, 40p. incl. diagrs. (AFOSR-TN-58-824) (AF 49(638)347) AD 202908; PB 138064 Unclassified

Presented at West Coast conf. of the Amer. Soc. Mech. Engineers, Stanford, Calif., Sept. 9-11, 1959.

Also published in Jour. Appl. Mech., v. 27: 16-24, Mar. 1960.

An approximate method, known as the heat balance integral, is used to determine the melting rate of a finite slab which is initially at a uniform temperature below the melting point. The slab is acted upon by a constant heat input at one face and has its other face either insulated or kept at its initial temperature. The first three terms of series solutions in an intrinsically small parameter are obtained for the time histories of melting and the temperature distribution in the slab. (Contractor's abstract)

AIP.01:001

American Inst. of Physics, New York.

PHYSICS OF FLUIDS, ed. by F. N. Frenkiel. 1958-1960. (AF 49(638)275) Unclassified

This publication is devoted to original contributions to the physics of fluids covering kinetic theory, statistical mechanics, structure and general physics of gases, liquids, and other fluids, as well as certain basic aspects of the physics of fluids bordering geophysics, astrophysics, biophysics, and other fields of science. The scope of these fields of physics includes: magneto-fluid dynamics, ionized fluid and plasma physics, shock and detonation wave phenomena, hypersonic physics, rarefied gases and upper atmosphere phenomena, physical aeronomy, transport phenomena, hydrodynamics, dynamics of compressible fluids, boundary layer and turbulence phenomena, liquid state physics, and superfluidity. Beginning as a bimonthly publication on January 1958, this journal will become a monthly as soon as it appears desirable.

AMF.02:003

American Machine and Foundry Co. Turbo Div., Pacoima, Calif.

ROCKET SCALING TESTS WITH A CONSTANT RATIO OF CHEMICAL TO WAVE PROPAGATION TIMES, by S. S. Penner. Apr. 19, 1957, 12p. (Rept. no. AMF/TD 1031; technical note no. 3) (AFOSR-TN-57-231) (AF 18- (803)107) AD 126528 Unclassified

Representative scaling procedures are described for an experimental study of the practical significance of maintaining a constant ratio of chemical to wave propagation times. The test procedures are developed in such a way as to make economical use of a given rocket engine configuration.

American Machine and Foundry Co. Turbo Div., Pacoima, Calif. see also Sunstrand Machine Tool Co. Sunstrand Turbo Div., Pacoima, Calif.

AMS.03:001

American Mathematical Soc., Providence, R. I.

SEMINAR IN APPLIED MATHEMATICS, BOULDER, COLORADO, JUNE 23, 1957-JULY 19, 1957. Final descriptive rept. Dec. 20, 1957, 1v. (AFOSR-TR-58-2) [AF 49(638)59] AD 148036 Unclassified

This report contains summaries of lectures that were given on the following basic courses: (1) Solid Mechanics (12 lectures); (2) Fluid Mechanics (12 lectures); (3) Probability and Related Topics in Physical Sciences

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AMS. 04:001; AMS. 05:001;
APS. 01:001; ASM. 02:001

(12 lectures); (4) Hyperbolic and Parabolic Partial Differential Equations (8 lectures); and (5) Elliptic Partial Differential Equations (8 lectures).

AMS.04:001

American Mathematical Soc., Providence, R. I.

MATHEMATICS ADVISORY AND EVALUATION SERVICES. Sept. 30, 1957-May 31, 1959. (AF 49(838)-204; continuation of AF 18(800)994) Unclassified

This contract provides for a reviewing panel of outstanding mathematicians in select and specialized areas of mathematics, who evaluate proposals and the research accomplished under contract, upon request. The evaluations are performed on an individual basis, usually by correspondence, for proposals or technical results of a rather complex nature, concerning which the expert advice of mathematicians practicing in that area is desired. Such evaluations form part of the basis on which the overall research being performed under contract is critically analyzed and evaluated. The contract also provides for a permanent panel of six of the world's leading mathematicians to provide a continuing overall appraisal of the Air Force research program in mathematics, to insure that the common interests of the Air Force and the mathematical community are effectively advanced in accord with the best interests of the country.

AMS.05:001

American Mathematical Soc., Providence, R. I.

MATHEMATICAL REVIEWS, ed. by J. V. Wehausen and S. H. Gould. 1949-1958. (AF 49(638)239; continuation of AF 18(600)132) Unclassified

Unavailability of the German comprehensive reviewing and abstracting service for mathematics during World War II caused the American Mathematical Society to start its own abstracting service. This effort was supported in part by the Office of Naval Research (1946-1949) and then by the Air Force Research and Development Command (1949-1958) under what eventually became the Mathematical Sciences Directorate of Air Force Office of Scientific Research. A yearly rate of over 5,000 abstracts has been maintained, amounting to 11 volumes each year. Mathematical Reviews is the only comprehensive English language mathematical abstracting service. It covers all fields of mathematics from topology and advanced algebra to mathematical physics and mechanics. It obtains and abstracts all the major and most of the minor mathematical publications in the world and deliberately stresses papers written in Russian and less accessible languages by providing more comprehensive reviews of these papers. Mathematical Reviews at the present time uses over 750 reviewers who are the recognized authorities in their respective

fields to provide useful, authoritative and complete reviews. These reviewers and the elected officers of the Society carry out their duties as a service to science and for the prestige involved.

APS.01:001

American Physiological Soc., Washington, D. C.

REPORT OF PRESENT TRENDS IN PHYSIOLOGICAL AND BIOLOGICAL RESEARCH AS REPORTED AT THE TWENTIETH INTERNATIONAL PHYSIOLOGICAL CONGRESS, Brussels (Belgium), July 30-Aug. 4, 1956. Nov. 1956, lv. incl. table. (AFOSR-TR-57-81) (AF 18-(603)64) AD 119051 Unclassified

This report consists of articles written by the American physiologists who attended the congress by means of contract funds. Twelve articles discussing the following topics summarize and evaluate the papers presented: (1) physiology in Scandinavia, West Germany, Switzerland, Belgium, France, Britain, Yugoslavia, Russia, and other countries; (2) carotid sinus; (3) PO_2 in the blood; (4) cell measurements; (5) the blood brain barrier; (6) effect of drugs on the "psyche"; (7) pulmonary function testing; (8) intermediary metabolism, neurophysiology, pharmacology, endocrines and neurosecretion of invertebrates; (9) environmental human physiology; (10) temperature regulation and peripheral circulation; (11) human performance; (12) psychopharmacology; (13) the physiological effects of gravitational stress; (14) active transport; (15) human and insect respiration; (16) renal physiology; (17) smooth muscle and muscle contraction; (18) marine biology; (19) new techniques in studies on basic cellular processes; and (20) comparative and cellular physiology. A list of the symposia and of the number of papers given in each general area of research is included.

ASM.02:001

American Soc. of Mechanical Engineers, New York.

APPLIED MECHANICS REVIEWS, ed. by M. Goland. 1957-1958. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under Nonr-251300) Unclassified

This is a monthly review of current literature in the field of theoretical and applied mechanics in order to make edited abstracts accessible. Topics covered include: (1) General - analytical methods in applied mechanics, computing methods and computers, analogies, kinematics, rigid dynamics and oscillations, instrumentation and automatic control, tables, charts, dictionaries, etc.; (2) Mechanics of Solids - elasticity, viscoelasticity, plasticity, rods, beams and strings, plates, shells and membranes, buckling, vibration of solids, wave motion and impact in solids, fundamental soil mechanics, applied soil mechanics, processing of metals and other materials.

ANT.02:004 - ANT.02:007

fracture (including fatigue), experimental stress analysis, material test techniques, properties of engineering materials, simple structures, composite structures, machine elements and machine design, fastening and joining methods; (3) Mechanics of Fluids - hydraulics, incompressible flow, compressible flow (continuum and non-continuum flow), boundary layer, turbulence, aerodynamics, vibration and wave motions in fluids, fluid machinery, flow and flight test techniques and measurements; (4) Heat - thermodynamics, heat and mass transfer, combustion, prime movers and propulsion devices; (5) Combined Fields and Miscellaneous - magneto-fluid-dynamics, aeroelasticity, aeronautics, astronautics, ballistics, explosions, acoustics, micromeritics, porous media, geophysics, hydrology, oceanography, meteorology, naval architecture and marine engineering, friction, lubrication and wear.

ANT.02:004

Antioch Coll. Fels Research Inst., Yellow Springs, Ohio.

CONCURRENT FAT LOSS AND FAT GAIN, by S. M. Garn and R. W. Young. [1956] [8]p. incl. diagrs. table, refs. (AFOSR-TN-57-46) [AF 18(600)1566] AD 115084 Unclassified

Also published in Amer. Jour. Phys. Anthropology, v. 14 (new series): 497-504, Sept. 1956.

The thickness of the subcutaneous fat-plus-skin shadow was measured on standardized teleoroentgenograms of 338 white subjects aged 12.5 to 65 years. As expected, trochanteric fat increased in both sexes with the larger absolute increase observed in the females. Anterior leg fat diminished in both sexes, and to the same degree, reaching a near-minimum in the fourth decade. This phenomenon (fat loss during fat gain) was statistically significant by the F and χ^2 tests and indicated an adult rearrangement of fat. In discussing the subject, attention was called to trend reversals in infancy, at adolescence, and in specific fat depot sites in the adult. No evidence as to the underlying mechanism for this adult rearrangement was found. (Contr ctor's abstract)

ANT.02:005

Antioch Coll. Fels Research Inst., Yellow Springs, Ohio.

ROENTGENOGRAMMETRIC DETERMINATIONS OF BODY COMPOSITION, by S. M. Garn. Dec. 1957 [17]p. incl. diagrs. tables, refs. [AFOSR-TN-57-403] (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1566 and National Institute of Mental Health) AD 132481 Unclassified

Also published in Human Biology, v. 29: 337-353, Dec. 1957.

The weight of fat and the fat-free weight were estimated

on an individual basis for each of 251 adult males and females, using the thickness of iliac crest fat for females and trochanteric fat for males. The study was based upon standardized soft-tissue x-rays of the subjects. The roentgenogrammetric method has the particular advantage of being capable of providing information not only on fat (and therefore the fat-free mass), but also of providing estimates of muscle mass and skeletal weight as well.

ANT.02:006

Antioch Coll. Fels Research Inst., Yellow Springs, Ohio.

AN IMPROVED METHOD OF ESTIMATING BODY FAT CONTENT BY THE USE OF TELEOROENTGENOGRAMS, by S. M. Garn. Final rept. Jan. 9, 1957 [24]p. incl. diagrs. tables, refs. (AFOSR-TR-57-7) (AF 18(600)1566) AD 115085 Unclassified

Soft-tissue teleoroentgenograms were taken on 138 young adult males in order to further improve techniques for the estimation of body fat. A total of 12 fat sites were measured including the lateral and medial arm; deltoid "insertion"; lower thoracic, iliac crest and spine; upper and mid trochanteric; and medial, lateral, anterior, and posterior leg. In general, "central fat" showed the highest correlations with weight and the greatest degree of communality with other fat sites. The results indicate that while multiple sites yield somewhat better estimates of total body fat, the use of one or two sites, highly correlated with weight and showing maximum communality with other fat sites, often may be substituted. Further, one particular site (lower thoracic), while not the best single predictor of body fat, may be of considerable practical importance since this site is easily measured on conventional chest-plates such as are taken in mass radiographic studies.

ANT.02:007

Antioch Coll. Fels Research Inst., Yellow Springs, Ohio.

SELECTION OF BODY SITES FOR FAT MEASUREMENT, by S. M. Garn. [1957] [2]p. incl. diagr. table. (AF 18(600)1566) Unclassified

Published in Science, v. 125: 550-551, Mar. 22, 1957.

Fat measurements were made on a representative group of young adult American males. From a series of six regions x-rayed, measurements were made at 12 sites. These included the medial and lateral arm, the "pocket" formed by the triceps and deltoid muscles, the lower thoracic site, the iliac crest and spine, the upper and middle trochanteric sites, and the 4 quadrants of the lower leg. All fat thicknesses were positively inter-correlated, with values of r ranging from 0.32 to 0.96. In general, deltoid, thoracic, iliac, and trochanteric fat (areas of "central" fat) showed considerably higher group

ANT. 02:008; ANT. 03:001-002

intercorrelations than "peripheral" or extremity fat. Correlations with weight were also higher than those for the central fat sites. The iliac spine, mid-trochanteric, and lower thoracic exhibited the greatest degree of communality and the highest correlations with weight. While pelvic fat appears to be the best single predictor of fat in general, as is also true of the older adult male, the lower thoracic site may prove to be of considerable practical use.

ANT.02:008

Antioch Coll. Fels Research Inst., Yellow Springs, Ohio.

FAT WEIGHT AND FAT PLACEMENT IN THE FEMALE, by S. M. Garn. [1957] [2]p. incl. table. [AF 18(600)1566]
Unclassified

Published in Science, v. 125: 1091-1092, May 31, 1957.

Standardized soft tissue x-rays were taken on 107 healthy adult American-born women with a mean age of 39 and on 81 healthy adult males with a mean age of 40 years. Fat-shadow measurements were made at the following sites: lateral arm, medial arm, deltoid "pocket", iliac crest, mid-trochanteric, lateral leg, medial leg, anterior leg, and posterior leg. The women exceeded the men in 7 out of 9 fat-plus-skin measurements, with female/male ratios for subcutaneous fat up to a median value of 1.89. From the intercorrelation matrices, trochanteric fat emerged as the best single predictor of total fat for adult males; iliac crest fat had the greatest communality with other fat sites for the female. Prediction estimates on an individual basis indicated a median weight of fat for females of 13.7 kg, not markedly greater than the median of 12.6 kg for the males. Estimates based on other central fat sites were very similar. Relative to the total weight, the sex difference was marked. The % of fat was estimated as 23.7 for the females and 16.8 for the males. Since female subcutaneous fat thicknesses were generally greater, but total fat was not notably different, it follows that the sex difference in the proportion of outer and inner fat is considerable. Women carry more fat on and less in their smaller frames.

ANT.03:001

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

STUDIES OF THE DETERMINATION OF GERMANIUM BY THE HETEROPOLY BLUE METHOD. by E. R. Shaw and J. F. Corwin. Apr. 15, 1957 [16]p. incl. diagrs. table, refs. (Technical note no. 1) (AFOSR-TN-57-195) (Also bound as Appendix 1 with its AFOSR-TN-57-428; AD 136417) (AF 18(600)1490) AD 126490; AD 136417a
Unclassified

Also published in Anal. Chem., v. 30: 1314-1316, Aug. 1958. (Title varies)

The cause of the up to 100% variation in absorbancies found when identical samples were analyzed for GeO_2 by the heteropoly-blue molybdate complex method was traced to the differences in individual interpretation of the literature-recommended time interval between the addition of the molybdate and the reductant. By a time study, the optimum interval was selected, and the best acid and molybdate concentrations were determined with the result that different operators can obtain results which agree within 5%. (Contractor's abstract)

ANT.03:002

Antioch Coll. [Dept. of Chemistry] Yellow Springs, Ohio.

THE PHYSICAL CHEMISTRY OF WATER SOLUTIONS AT HIGH TEMPERATURES AND PRESSURES. Technical rept. [1957] 1v. incl. illus. tables, refs. [Technical note no. 2] (AFOSR-TN-57-428) (AF 18(600)1490) AD 136417
Unclassified

Research was conducted on 3 aspects of H_2O solutions.

(1) The GeO_2 - H_2O system: The possibility of producing new crystalline forms of GeO_2 was investigated by the hydrothermal process. The reactions of H_2O with GeO_2 resulted in formation of soluble or insoluble forms of GeO_2 . The reactions of basic solutions (NaOH) produced 2 uncharacterized forms, $\text{Na}_2\text{Ge}_4\text{O}_9$ and

$\text{Na}_3\text{HGe}_7\text{O}_{16} \cdot 4\text{H}_2\text{O}$. The 2 forms were described from a crystallographic viewpoint and a mechanism was proposed for their formation. (2) Conductivity of H_2O solutions: A

number of autoclave modifications were tested for hydrothermal measurements at and above the critical temperatures. Only one modification (i.e. autoclave with spark plug) was successful, and measurements indicated either a 2-phase system or a density gradient above the critical point. As the solution charge increased the system became more homogeneous. (3) Reactions of SiO_2 and H_2O solutions: Reactions of $\text{Ca}(\text{OH})_2$ and SiO_2 were investigated under controlled conditions. The reaction involved a slow devitrification of silica glass which added a regulated amount of SiO_2 to the solution. The mechanism

consisted of the formation of xonotlite, $5\text{CaO} \cdot 3\text{SiO}_2 \cdot \text{H}_2\text{O}$, then amorphous SiO_2 which transformed to β -cristobalite and finally to α -cristobalite. The reactions of $8\text{r}(\text{OH})_2$ with SiO_2 were investigated. The reactions and mechanism were approximately the same as those for $\text{Ca}(\text{OH})_2$.

The α -quartz-cristobalite transformation was sensitive to the pH of the solution and to the presence of certain ions which on hydrolysis form sufficient OH to cause silica glass to be transformed either into cristobalite or α -quartz. (ASTIA abstract, modified)

ANT.03:003 - ANT.03:006

ANT.03:003

Antioch Coll. [Dept. of Chemistry] Yellow Springs, Ohio.

FACTORS GOVERNING THE HYDROTHERMAL FORMATION OF CRISTOBALITE AND QUARTZ, by R. G. Yalman. [1957] [15]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1490] and Signal Corps under [DA 36-039-sc-64605]) Unclassified

Published in Proc. Eleventh annual Symposium on Frequency Control, Asbury Park, N. J. (May 7-9, 1957), Ft. Monmouth, N. J., Army Signal Engineering Labs., 1957, p. 142-156.

In studying the hydrothermal growth of quartz under isothermal conditions good results were obtained at 400° in a bomb 50% filled with 40M solutions of various compounds. Nutrient solutions used were $\text{Ca}(\text{OH})_2$, NaF, Na_2SO_4 , CaSO_4 , H_2SO_4 , HCl, pure H_2O , and NaOH. The following conclusions were established: (1) devitrification takes place in weakly alkaline solutions with the formation of cristobalite and in stronger alkaline solutions with the formation of quartz; (2) the specific mineralizing properties of individual ions are due to the hydrolysis of these ions with the subsequent formation of hydroxide ion; and (3) the formation of insoluble oxides or silicates decreases the hydroxide ion concentration of the nutrient solutions at 400° causing a corresponding decrease in devitrification of silica glass and in the formation of cristobalite and quartz. (Contractor's abstract, modified)

ANT.03:004

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS UNDER SUPERCRITICAL CONDITIONS. I. SILICA IN THE PRESENCE OF ALKALINE EARTH METAL OXIDES, by J. F. Corwin, R. G. Yalman and others. [1957] 10p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1490] and Signal Corps under [DA 36-039-sc-64605]) Unclassified

Published in Jour. Phys. Chem., v. 61: 939-940, July 1957.

The hydrothermal reactions between dilute water solutions of earth metal oxides and silica glass were studied under carefully controlled experimental conditions at temperatures and pressures well above those associated with the critical conditions for water and water solutions. Under these conditions calcium and strontium oxides reacted rather rapidly with the silica and the reaction products, calcium and strontium silicates, were sufficiently soluble in water so that the silica glass continued to devitrify. The oxides of barium and magnesium reacted much less rapidly and

beryllium oxide almost not at all. Barium and magnesium oxides form coatings on the silica surface that inhibit further reaction. The beryllium oxide does not react with silica under these conditions. (Contractor's abstract)

ANT.03:005

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS UNDER SUPERCRITICAL CONDITIONS. II. THE REACTION BETWEEN CALCIUM HYDROXIDE AND SILICA, by J. F. Corwin, R. G. Yalman and others. [1957] [14]p. incl. illus. tables, refs. (Bound as Appendix 2 with its AFOSR-TN-57-428; AD 136417) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1490 and Signal Corps under DA 36-039-sc-64605) AD 136417b Unclassified

Also published in Jour. Phys. Chem., v. 61: 941-943, July 1957.

The hydrothermal reaction between dilute solutions of calcium hydroxide and silica glass was studied under carefully controlled experimental conditions at 400°, 340 atm pressure, and in a time range from 0 to 192 hrs. Through the devitrification of a controlled amount of silica glass rod, silica was added slowly to the solution during the reaction. Under these conditions xonotlite was formed first, and on continued reaction the solid phase modified through a series of crystalline and amorphous materials to β -cristobalite and finally to α -cristobalite. (Contractor's abstract)

ANT.03:006

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS UNDER SUPERCRITICAL CONDITIONS. III. THE EFFECT OF pH ON THE CRYSTALLIZATION OF SILICON DIOXIDE, by R. G. Yalman and J. F. Corwin. [1957] [26]p. incl. diagrs. tables, refs. (Bound as Appendix 4 with its AFOSR-TN-57-428; AD 136417) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1490 and Signal Corps under DA 36-039-sc-64605) AD 136417d Unclassified

Also published in Jour. Phys. Chem., v. 61: 1432-1437, Oct. 1957.

The hydrothermal reactions of silica glass have been studied under isothermal conditions at 400°C and 5000 psi. The results indicate that no reaction occurs with sulfuric, phosphoric, and hydrofluoric acids, in potassium hydrogen sulfate solutions or in pure water. In weak sodium hydroxide solutions silica glass devitrifies to form cristobalite, and in stronger sodium hydroxide solutions quartz is formed. The mechanisms of these

ANT.03:007 - ANT.03:010

reactions involve the trihydrogen and dihydrogen silicate ions. Similar results are obtained with increasing pH in buffered phosphate, sulfate, and fluoride solutions. The formation of quartz and cristobalite in these solutions is due to the hydrolysis of the anions present. There is no evidence that hydrothermal reactions of silica glass at 400°C in fluoride containing solutions are due to the formation of the fluosilicate ion. (Contractor's abstract)

ANT.03:007

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS UNDER SUPERCRITICAL CONDITIONS. IV. THE REACTION BETWEEN STRONTIUM HYDROXIDE AND SILICA, by J. F. Corwin, R. G. Yalman and others. [1957] [9]p. incl. diagr. tables. (Bound as Appendix 3 with its AFOSR-TN-57-428; AD 136417) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1490 and Signal Corps under DA 36-039-sc-64605) AD 136417c Unclassified

Also published in Jour. Phys. Chem., v. 61: 1437-1439, Oct. 1957.

The hydrothermal reaction between dilute solutions of strontium hydroxide and silica glass was studied under carefully controlled experimental conditions at 400°, 340 atm pressure, and in a time range from 0 to 192 hrs. Through the devitrification of a controlled amount of silica glass rod, silica was added slowly to the solution during the reaction. Under these conditions strontium metasilicate was formed first, and on continued reaction the solid phase modified through a series of crystalline and amorphous materials to β -cristobalite and finally to α -cristobalite. In this respect the reaction closely resembles that of calcium hydroxide under the same conditions. (Contractor's abstract)

ANT.03:008

Antioch Coll. [Dept. of Chemistry] Yellow Springs, Ohio.

PROGRAM FOR STUDYING THE EFFECT OF FLUORIDE ION ON THE HYDROTHERMAL FORMATION OF QUARTZ. [1957] [15]p. (Bound as Appendix 5 with its AFOSR-TN-57-428; AD 136417) [AF 18(600)1490] AD 136417c Unclassified

Studies were made of the effect of F^- on the crystallization of cristobalite and quartz under isothermal conditions at 400° and 350 atm and of the stability of SiF_6^{2-} at room temperature. Studies indicated that the mineralizing action of F^- is due to the hydrolysis of F^- and not to the formation of SiF_6^{2-} . The concentration of the OH^- formed during hydrolysis determines the kind of crystalline SiO_2 produced. In essentially neutral or acid

solutions, including HF, neither cristobalite nor quartz is formed. Cristobalite is the main product when the amount of OH^- formed is 0.005 M or less. At higher concentrations quartz is the primary product. (ASTIA abstract)

ANT.03:009

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS IN THE Na_2O - GeO_2 SYSTEM, by E. R. Shaw, J. F. Corwin, and J. W. Edwards. Sept. 9, 1957 [4]p. incl. tables, refs. (AF 18-(600)1490) Unclassified

Published in Jour. Amer. Chem. Soc., v. 80: 1536-1539, Apr. 5, 1958.

The hydrothermal reactions between GeO_2 and water and water solutions containing sodium hydroxide have been studied at temperatures between 100 and 400°, and in the time range from 1 to 384 hours. The reaction of GeO_2 with water resulted in no new crystalline forms, but with solutions containing sodium hydroxide two crystalline forms having the proposed formulas $Na_3HGe_7O_{16} \cdot 4H_2O$ and $Na_2Ge_4O_9$ were prepared in such quantity that optical recognition and properties were easily established. The anhydrous material has heretofore been prepared by ignition only. On the basis of chemical analysis and pH determination mechanisms for the formulation of these crystals are proposed. (Contractor's abstract)

ANT.03:010

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

A CHALCEDONY-LIKE VARIETY OF GERMANIA, GeO_2 , by J. F. White, E. R. Shaw, and J. F. Corwin. Sept. 1957 [5]p. incl. illus. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)1490 and Signal Corps Engineering Labs. under DA 36-039-sc-64605 and DA 36-039-sc-73211) Unclassified

Published in Amer. Mineralogist, v. 43: 580-584, May-June, 1958.

A fibrous variety of GeO_2 (quartz type) was produced hydrothermally. It has anomalous physical and optical properties which are analogous to the corresponding form of silica, chalcedony. Accordingly, this variety may be termed chalcedonic germania. Refractive indices determined for single crystals of GeO_2 (quartz type) are slightly different from those previously reported. (Contractor's abstract)

ANT.03:011; ARD.01:006-009

ANT.03:011

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS UNDER SUPER-CRITICAL CONDITIONS. V. REACTIONS BETWEEN SILICA AND ALKALINE EARTH METAL SALTS, by J. F. Corwin. [1958] [3]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1490 and Signal Corps under DA 38-039-sc-64605)
Unclassified

Published in Jour. Phys. Chem., v. 62: 1086-1088, Sept. 1958.

The reaction of dilute solutions of the salts of the alkali earth metals with silica has been investigated by using the devitrification of clear fused quartz as a measure of the rate of reaction, and x-ray, optical and chemical analysis as a measure of the structure of the crystallized material. By carrying out these reactions under controlled conditions using compounds of the alkaline earth metals it has been found that the crystalline structures resulting from the reactions of these solutions vary in a systematic way from α -cristobalite and several other modifications of the silica structure to silicate minerals. The rate of reaction and the formation of crystalline structures are correlated with the initial pH of the solution and the relative dimensions of the ions involved. On the basis of these correlations, the natural occurrence of α -quartz and talc is inferred since the concentration of these dilute solutions is quite similar to that of ground water. (Contractor's abstract)

ARD.01:006

ARDE Associates, Newark, N. Y.

VOLUMETRIC RATES OF ENERGY RELEASE CHARACTERISTIC OF DIFFERENT MECHANISMS OF TURBULENT COMBUSTION IN PREMIXED GASES, by R. R. John. Dec. 1956, 24p. incl. diagrs. refs. (Technical note no. 4555-4) (AFOSR-TN-57-5) (AF 18(600)-1560) AD 115036
Unclassified

Estimates have been made of the volumetric rates of energy release (SHR) characteristic of different mechanisms of turbulent combustion in premixed gases, including the wrinkled laminar flame, the zone of instantaneous mixing. On the basis of the absolute value and the pressure dependence of the SHR, it is suggested that the zone of extended reaction is the turbulent combustion process occurring in contemporary continuous flow combustion systems. (Contractor's abstract)

ARD.01:007

ARDE Associates, Newark, N. J.

REVIEW OF FLAME STABILIZATION ON BLUFF

BODIES, by R. R. John and E. Mayer. Feb. 1957 [40]p. incl. diagrs. tables, refs. (Technical note no. 4555-5) (AFOSR-TN-57-228) (AF 18(600)1560) AD 126528
Unclassified

The current status of fundamental and technological researches on flame stabilization is reviewed. From the technological viewpoint, the dependence of stability limits on combustible temperature, pressure, velocity, mixture ratio, and flameholder size can be described in terms of scaling parameters; no systematic correlations are available for the description of the variation of stability limits with burner/flameholder geometry, inlet turbulence, or other inlet inhomogeneities. From the fundamental viewpoint, the gross features of the aerodynamic, thermal and chemical structure of the stabilizer wake have been identified. While the fundamental researches have led to a reasonably clear understanding of the flame stabilization mechanism, technical flame holder design and development have benefited only indirectly from the results of the fundamental investigations.

ARD.01:008

ARDE Associates, Newark, N. Y.

A THEORY OF FLAME PROPAGATION LIMITS DUE TO HEAT LOSS, by E. Mayer. June 1957 [34]p. incl. diagrs. tables, refs. (Technical note no. 4555-8) (AFOSR-TN-57-296) (AF 18(600)1560) AD 132367
Unclassified

Also published in Combustion and Flame, v. 1: 438-451, Dec. 1957.

An energy balance equation for the flame front relates the actual flame temperature T_f to the adiabatic temperature T_f^a and a heat loss parameter λ . From this equation real values of T_f are possible only for limited ranges of T_f^a and λ , depending on the character of the heat loss mechanism. Flame propagation limit criteria are deduced for the special cases of (1) convective heat loss applicable to flame quenching in a circular tube, and (2) radiative heat loss applicable to free flames near the composition limit. Illustrative numerical applications are made to hydrocarbon/air data. The theoretical results for both quenching and composition limits are in satisfactory agreement with the observed data.

ARD.01:009

ARDE Associates, Newark, N. Y.

SURVEY OF THE ROLE OF CHEMISTRY IN PREMIXED COMBUSTION PHENOMENA, by E. Mayer and R. R.

ARK.01:010 - ARK.01:013

John. Final rept. Oct. 1957, iv. diagrs. tables, refs.
(Technical rept. no. 4555-2) (AFOSR-TR-57-70) (AF 18-
(600)1560) AD 136647; PB 151238 Unclassified

The role of chemistry in premixed gaseous combustion phenomena is discussed on the basis of a critical survey of the literature. The phenomena considered include laminar flame propagation, space-homogeneous combustion, ignition, quenching and stability limits. Problem areas of interest are described. An annotated selective bibliography dealing primarily with current topics concludes the discussion of each phenomenon considered. (Contractor's abstract)

ARK.01:010

Arkansas U. Dept. of Chemistry, Fayetteville.

THE COORDINATION OF COPPER (II) IN KCuCl_3 ,

by R. [F.] Kruh and C. W. Diggins, Jr. [1956] [11]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-57-5; AD 115070 as Appendix X) (AF 18(600)960)
Unclassified

The crystal structure of KCuCl_3 has been determined by x-ray diffraction. The structure is related to that of KdCl_3 by a distortion which permits 4 + 2 coordination for copper. Copper's six chlorine neighbors are at the corners of tetragonal bipyramids joined to form infinite chains parallel to the c-axis. Lattice constants are $a = 8.87$, $b = 13.87$, $c = 4.05\text{\AA}$, $\beta = 98.13^\circ$, and the space group is $P2_1/a$. (Contractor's abstract)

ARK.01:011

Arkansas U. Dept. of Chemistry, Fayetteville.

ELECTRODE POTENTIALS IN FUSED SYSTEMS. IV. A THERMODYNAMIC AND KINETIC STUDY OF THE AgCl-NaCl SYSTEM, by K. H. Stern and T. E. Wilson. [1956] [22]p. incl. diagrs. tables. (Bound with its AFOSR-TR-57-5; AD 115070 as Appendix IV)
(AF 18(600)960) Unclassified

Presented at meeting of the Phys. and Inorg. Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Abstract published in 131st meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 36R.

Also published in Jour. Phys. Chem., v. 62: 385-390, Apr. 22, 1958.

In Part II of this series the cell Ag/AgCl, KCl/Cl_2 was shown to behave reversibly from pure AgCl to a mole fraction of about 0.05. It was shown that the free energy of dilution of AgCl by KCl is linear with concentration down to the lower value and then drops sharply toward

minus infinity, i.e., thermodynamic functions cannot be obtained for systems which behave irreversibly. In agreement with the results obtained by other authors for the AgBr-KBr system, the ΔF of dilution in the AgCl-KCl system also deviates negatively from ideality. For the AgBr-NaBr system these authors had already found a positive deviation. It therefore seemed of interest to carry a system showing such deviation to lower concentrations to see if an abrupt reversal of slope would occur at some critical concentration. In the previous paper, some preliminary results were reported that showed silver to react with KCl , the reaction being driven by the distillation of the alkali metal. The fact that the solutions were not stirred constantly prevented us from obtaining accurate rate data. In the present work the kinetics of the reactions $\text{Ag} + \text{NaCl} \rightarrow \text{AgCl} + \text{Na}$ are reported in some detail. This type of oxidation-reduction reaction has been used extensively for preparative purposes. For example, metallic sodium has been prepared from its fused halides by reduction with less active metals, the distilled sodium being condensed in cooler portions of the system. (Contractor's abstract)

ARK.01:012

Arkansas U. Dept. of Chemistry, Fayetteville.

A STUDY OF THE SYSTEM KCl-NiCl_2 , by R. F. Kruh and A. P. Lockhart. [1956] [3]p. incl. diagr. (Bound with its AFOSR-TR-57-5; AD 115070 as Appendix VII)
(AF 18(600)960) Unclassified

A thermal analysis of the system KCl-NiCl_2 was undertaken to provide a possible explanation of the color change that results from heating mixtures of nickel chloride and potassium chloride. The change is a striking one from yellow to blue as the temperature rises, and it is reversible. It was felt that this change might have its origin in a crystal transition of a possible compound formed by KCl and NiCl_2 . Although a compound KNiCl_3 appears to be formed it was concluded that (1) there was no thermal indication of a crystal transition for KNiCl_3 either above or below the eutectic temperature, viz. 504°C ; and (2) the high vapor pressure of NiCl_2 made it impossible to complete the phase diagram in the apparatus used. (Contractor's abstract, modified)

ARK.01:013

Arkansas U. Dept. of Chemistry, Fayetteville.

THERMODYNAMICS OF ION-PAIR DISSOCIATION. TETRABUTYLAMMONIUM PICRATE IN ORTHO- AND META-DICHLOROBENZENE, by P. H. Flaherty and K. H. Stern. [1956] [9]p. incl. diagr. tables, refs. (Bound with its AFOSR-TR-57-5; AD 115070 as Appendix V) (AF 18(600)960) Unclassified

ARK.01:014; ARK.02:002;
ATE.01:010, 011

The dissociation constant of Bu_4NPI has been measured in ortho- and meta-dichlorobenzene at 25, 35, and 45°C. The thermodynamic functions for the dissociation process are calculated and are presented in tabular form.

ARK.01:014

Arkansas U. Dept. of Chemistry, Fayetteville.

HIGH-TEMPERATURE CHEMISTRY OF FUSED SUBSTANCES, by R. F. Kruh. Final rept. Mar. 1, 1957, iv, incl. diagrs. tables, refs. (AFOSR-TR-57-5) (AF 18(600)960) AD 115070 Unclassified

Work under the contract consisted of 4 general areas: (1) high-temperature electrochemistry, (2) the thermodynamics of ion-pair formation, (3) the stereochemistry of complex ions, and (4) molten-state reactions. Studies were made on fused-salt solutions by measurements with galvanic cells and on their reactions with metals. These reactions, mainly between Ag and NaCl, were classified in table form. Experiments were performed on electrolyte-solvent interactions in solvents with low dielectric constants and the thermodynamic functions calculated. Ion orientation in high-temperature modifications of alkali-metal bifluorides was found to involve randomization rather than free or hindered rotation. Appendices are included containing technical reports and reprints of published articles.

ARK.02:002

Arkansas U. [Dept. of Physics] Fayetteville.

ISOTOPE SHIFTS IN THE Mol SPECTRUM (Abstract), by R. H. Hughes. [1957] [1]p. [AF 18(603)26] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 200, Apr. 25, 1957.

The isotope shift in $\text{Mol } 4d^4 5s^2 \text{ } ^3D_4 - 4d^5 5p \text{ } ^3P_3^0$ transition at $\sigma = 16\,577$ kayzers ($\lambda = 6031\text{\AA}$) has been studied in the hollow cathode spectrum from enriched even isotopes with a Fabry-Perot interferometer. The 94 - 92, 96 - 94, 98 - 96, 100 - 98, and 100 - 92 shifts in millikayzers are -25.6, -18.5, -12.0, -26.0, and -83.9, respectively. The minus sign indicates a shift in the field effect direction. The estimated limit error of the measurements is ± 1.5 mK. The direction of the variation in the shifts was predicted by the position of the first excited states and the electric quadrupole transition probabilities as measured by Coulomb excitation when these quantities are related to the isotope shift through the intrinsic deformation of these even-even nuclei. The

magnitude of these variations is smaller, however, than would be expected in terms of the deformation parameters as calculated by Heydenburg and Temmer.

Armour Research Foundation, Chicago, Ill. see Illinois Inst. of Tech. Armour Research Foundation, Chicago.

ATE.01:010

Ateliers de Constructions Electriques de Charleroi (France).

THE EFFECT OF THE SELF-MAGNETIC FIELD UPON THE CHARACTERISTICS OF A POSITIVE COLUMN IN THE GENERAL CASE, by M. Hoyaux and P. Gans. [1954] 14p. incl. diagrs. (Rept. no. EOARDC-TN-54-2) [AFOSR-TN-57-271] (AF 61(514)630-C) AD 126573 Unclassified

The motion of the charge carriers in the positive column of an electrical discharge in a gas is investigated, taking into account the forces due to the self-magnetic field of the arc and considering the general case in which no particular symmetry is assumed for the system. An expression for the mean drift velocity of the charge carriers is established, taking into account the principle of ambipolar diffusion. This also enables the component of the electric field in the direction of the ionization density gradient to be found. In a previous investigation (ATE.01:001) of a discharge in which the self-magnetic field is assumed to be negligible, it was found that the component of the electric field perpendicular to the ionization density gradient derived from a potential which was called the primitive potential. In this paper, the condition that a primitive should exist in the general case is examined. The resulting condition seems to have no immediate physical interpretation and needs to be examined in detail for each particular geometry considered. Finally, the fundamental equations for the energy balance of the electrons and the conservation of charge are established together with the equation of continuity. These results are generalizations of those previously obtained for the case in which the self-magnetic field is neglected. (Contractor's abstract)

ATE.01:011

Ateliers de Constructions Electriques de Charleroi (France).

PRELIMINARY EXPERIMENTS WITH AN IMPROVED TYPE OF PLASMOGRAPH, by M. Hoyaux and P. Gans. [1955] iv, incl. diagrs. (Rept. no. EOARDC-TN-55-1) [AFOSR-TN-57-272] (AF 61(514)630-C) AD 66706 Unclassified

An improved type of plasmograph having an extremely low resolving time of the order of 2 μsec is described. This instrument permits the measurement of Langmuir

ATE.01:012 - ATE.01:014

probe characteristics for a discharge excited by an alternating electric field. It functions by selecting one point on the probe characteristic during each cycle of operation. The probe potential is varied between cycles so that a different point on the characteristic is recorded on each successive cycle. It is, of course, necessary that the point observed on each cycle should correspond exactly to the same instant in phase. In this way, the characteristic corresponding to that instant in phase is obtained. By varying the phase at which the points are observed, the probe characteristics, and hence, the plasma parameters can be obtained for the whole cycle of operations. Preliminary experiments have been carried out in order to evaluate the performance of the plasmograph. The results are extremely interesting although the experiments are not sufficiently extensive to permit definitive conclusions to be drawn. It appears, however, that during the striking of the arc, a series of waves of ionization travels along the tube with a velocity of the order of some 100's of m/sec.

ATE.01:012

Ateliers de Constructions Electriques de Charleroi
(France).

THE EFFECT OF THE IONIZATION DUE TO ATOMS IN A METASTABLE EXCITED STATE UPON THE CHARACTERISTICS OF A POSITIVE COLUMN WITH AXIAL SYMMETRY, by M. Hoyaux and P. Gans. [1955] [47]p. incl. diagrs. tables. (Rept. no. EOARDC-TN-55-3) (AFOSR-TN-57-273) (AF 61(514)630-C) AD 80098
Unclassified

Previous investigation of the effect of the self-magnetic field upon the characteristics of a Hg-vapor arc is extended to the case in which the ionization due to the presence of Hg atoms in metastable excited states in the plasma is not negligible. Hg has a metastable excited state whose energy is more than half the ionization potential. The following types of processes involving these atoms were considered to lead to the creation of ion-pairs: (1) collisions of the second kind between 2 atoms in metastable states, and (2) direct ionization of an atom in a metastable state by collision with a free electron. The contribution of these 2 processes to the resultant ionization density was considered and an integro-differential equation was set up which takes into account both this effect and that of the self-magnetic field. This equation involves a parameter (A) which measures the influence of the self-field, and another (B) which measures the contribution due to the metastable atoms. The equation was solved numerically by means of punched card machines for a range of values of the 2 parameters. A set of nomographs were plotted, based on these solutions, which enable A and B and the electron temperature to be determined for given values of the discharge parameters. The graphs indicate that in the range of pressures, etc. normally used in practical Hg arc rectifiers, the influence of the metastable atoms upon the value of the arc drop is

negligible. The effect was in the direction of a decrease in the arc drop as was the case for the effect of the self-magnetic field alone. The cause for the observed increase in arc drop for heavy current was undetermined. (ASTIA abstract)

ATE.01:013

Ateliers de Constructions Electriques de Charleroi
(France).

THE INFLUENCE OF THE GVOSDOVER EFFECT UPON THE CHARACTERISTICS OF A POSITIVE COLUMN WITH AXIAL SYMMETRY IN THE DOMAIN IN WHICH THE SELF-MAGNETIC FIELD IS IMPORTANT, by M. Hoyaux and P. Gans. [1955] [49]p. incl. diagrs. tables, refs. (Rept. EOARDC-TN-55-4) (AFOSR-TN-57-274) (AF 61(514)630-C) AD 80099
Unclassified

A theoretical study has been conducted on the influence of the scattering of the electrons in the discharge by the coulomb microfield of the positive ions (Gvosdover Effect). This effect opposes the autostrictive effect of the self-magnetic field, and it is found that the radial distribution of the charge carriers tends more closely to that observed at low current densities (a zero order Bessel function) than if the self-field is considered to act alone. The integrodifferential equations for the case of a positive column with axial symmetry have been set up and solved numerically by means of punched-card machines. On the basis of these results, a graphical method has been developed for the determination of the arc drop in practical cases. The values of the axial electric field are found to increase with increasing current, the increases being in order of magnitude agreement with those observed experimentally upon mercury-arc rectifiers. (Contractor's abstract)

ATE.01:014

Ateliers de Constructions Electriques de Charleroi
(France).

INVESTIGATION OF THE DISCHARGE IN A FLUORESCENT TUBE BY MEANS OF A STROBOSCOPE, by M. Hoyaux and P. Gans. [1957] [10]p. incl. diagrs. (Rept. no. EOARDC-TN-55-6) (AFOSR-TN-57-275) (AF 61(514)630-C) AD 126577
Unclassified

A stroboscopic method has been employed to study the propagation of luminous fronts in fluorescent tubes both on striking and at extinction. The method is essentially that described previously by Ledrus. Measurements have been carried out on tubes with walls of "conducting" glass and of normal glass. There was no difference in the results with the limits of experimental error. On striking the tube, it was found that the luminous front, if it exists, is propagated with a velocity much greater than the maximum detectable by this method. This maxi-

ATH.01:001; ATL.01:002;
ATL.02:001

imum velocity is of the order of 50 km/sec. On extinction, luminous fronts leave the anode and cathode simultaneously with velocities of the order of 3 km/sec. They accelerate as they move towards the center and their velocities become unmeasurable. The dependence of the velocity on the wall temperature was investigated. The velocity was found to increase with increasing wall temperature. A theoretical interpretation of the behavior of the "extinction" fronts is suggested based on the decay of the residual ionization in the reverse half cycle. (Contractor's abstract)

ATH.01:001

Athens U. [Dept. of Physics] (Greece).

INVESTIGATION OF HEAT VIBRATIONS IN SOLIDS BY USING X-RAYS, by K. D. Alexopoulos. Feb. 1958, 10p. incl. diagrs. tables. (AFOSR-TN-58-225) (AF 61(514)-1248) AD 154126; PB 136192
Unclassified

Experiments were conducted to determine the characteristic temperature (θ) of various elements. The method consists in scattering a pencil of x-rays on the material under consideration and measuring the intensity of the diffracted rays. The integrated intensity of diffraction lines (111) and (422) of Ag was measured at 6 different temperatures between 81° and 774°K. The temperature of each measurement was determined from the angular shift of the diffraction line (422). By applying the formula of the usual Debye theory to each neighboring pair of temperatures a value of θ was obtained. Each value of θ corresponds to a temperature which lies at the middle of the temperature interval. The temperatures and the corresponding values for θ were as follows: (1) 138°K and 202; (2) 243°K and 233; (3) 405°K and 200; (4) 592°K and 178; and (5) 726°K and 121. For temperatures below 200°K, specific heat measurements can be used; they give values of θ around 215. Above 200°K, the specific heat measurements do not give accurate results. At higher temperatures, θ can be determined only from x-ray experiments. Measurements by Andriessen (Physica, v. 2: 417, 1935) gave a constant value of θ - 218 up to 670°K. An apparatus similar to that used for the Ag measurements was used on W at above room temperatures. The surface oxidized rapidly and all intensities gradually diminished. The difficulty was overcome by heating in a stream of hot CO₂. (Contractor's abstract, modified)

ATL.01:002

Atlantic Research Corp., Alexandria, Va.

TEMPERATURE-PROFILE STUDIES IN SOLID-PROPELLANT FLAMES, by R. G. Nugent, R. Friedman, and K. E. Rumbel. Mar. 1957 [22]p. incl. illus. diagrs. (AFOSR-TN-57-212) (AF 18(600)1502) AD 126509
Unclassified

Thermocouples have been fabricated of wire as small as 7.6 μ diameter and embedded in composite and double-base solid propellants. The propellants were ignited at high pressures and as the burning surface passed the thermocouple junction emf-vs-time curves were obtained simultaneously with high-speed motion pictures of the burning. It has been hoped that burning-surface temperatures could be obtained by refinement of such techniques, but the experimental difficulties, primarily thermocouple breakage and optical problems, showed that it is not practical to embed and observe sufficiently small thermocouples for the degree of space resolution which is required, at least for composite propellants oxidized with ammonium perchlorate. (Contractor's abstract)

ATL.02:001

Atlantic Research Corp., Alexandria, Va.

TURBULENT FLAME STUDIES IN A TWO-DIMENSIONAL OPEN BURNER, by J. H. Grover, E. N. Fales and A. C. Scarlock. [1958] [35]p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-106) (AF 49(638)177) AD 201514
Unclassified

Also published in ARS Jour., v. 29: 275-283, Apr. 1959.

A two-dimensional open burner has been developed for studying turbulent flames. Stoichiometric natural gas-air flames with inlet flow velocities of 15, 20, 30 and 40 ft per sec were investigated. Densitometer traverses of time exposures were used to locate the position of the mean flame front and its root-mean square displacement. Flash tube exposures of the flame with one micron magnesium oxide particles in the flow were taken to determine the flow lines into and through the flame front. The large reduction of brightness that occurred when the flow passed through the flame front, due to the reduction of particle concentration, shows clearly the outline of the instantaneously wrinkled flame front and the islands of unburned gas often present in the burned gas. From the intercepts of the flow lines and the mean flame front, the local turbulent flame velocity along the flame front was calculated. The turbulent flame velocity increased rapidly with distance above the burner rim. The flame velocity increase can be entirely accounted for by flame wrinkling. Both this result and the appearance of the flash tube photographs, showing the instantaneous flame front, support the wrinkled flame concept of turbulent flame propagation. (Contractor's abstract)

Auburn Research Foundation, Inc., Auburn, Ala. see Alabama Polytechnic Inst. Auburn Research Foundation, Inc., Auburn.

AVC.01:001 - AVC.01:004

AVC.01:001

AVCO Manufacturing Corp. AVCO Research Lab.,
Everett, Mass.

ON HYPERSONIC BLUNT-BODY FLOW WITH A MAGNETIC FIELD, by N. H. Kemp. Feb. 1958, 11p. incl. diagrs. (Research rept. no. 19) (AFOSR-TN-58-437) (AF 49(638)61) AD 205520 Unclassified

Also published in Jour. Aeronaut. Sciences, v. 25: 405-407, June 1958. (Title varies)

The purpose of this note is to present the effect of a magnetic field on the inviscid flow near the stagnation point of a blunt axisymmetric body in the practical case of small magnetic Reynolds number. It is stated that the main effect of the magnetic field is to change the inviscid rather than the viscous flow. This will make possible a prediction of the change in heat transfer and pressure drag caused by the field. The method used to analyze the flow is that introduced by Lighthill. In such case a spherical shock shape and incompressible flow are assumed.

AVC.01:002

AVCO Manufacturing Corp. AVCO Research Lab.,
Everett, Mass.

TWO-DIMENSIONAL INCOMPRESSIBLE MAGNETO-HYDRODYNAMIC FLOW ACROSS AN ELLIPTICAL SOLENOID, by N. H. Kemp and H. E. Petschek. Apr. 1958, 66p. incl. diagrs. (Research rept. no. 26) (AFOSR-TN-58-438) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)61 and Air Force Ballistic Missiles Div. under AF 04(645)18) AD 159613 Unclassified

Also published in Jour. Fluid Mech., v. 4: 553-564, Nov. 1958.

An analysis has been made of the two-dimensional flow of an incompressible, constant-conductivity fluid through an elliptically-shaped solenoid containing a constant magnetic field directed normal to the flow plane. The effect of both Hall current and ion slip has been included in the Ohm's Law used for the fluid. The analysis was performed by means of a perturbation procedure in two parameters, one being the magnetic Reynolds number R_m and the other the ratio of magnetic force per unit area to dynamic pressure, S . Calculations were carried through the first order in each parameter, and closed-form analytic expressions were obtained for the force and moment on the solenoid, the current density, stream function, magnetic field and other pertinent physical quantities. It was found that for the zero order, there is a force but no moment on the solenoid. For the first order in S , where the flow field changes but the magnetic field does not, there is a moment and a force, the latter being antiparallel to

the zero order force. For the first order in R_m , where the magnetic field changes but the flow field does not, there is a moment, but no force. Thus, through the first order the lift to drag ratio is the same as the zero order. (Contractor's abstract, modified)

AVC.01:003

AVCO Manufacturing Corp. AVCO Research Lab.,
Everett, Mass.

THE PRODUCTION OF HIGH TEMPERATURE GAS BY MAGNETIC ACCELERATION, by G. S. Janes and R. M. Patrick. Mar. 1958, 13p. incl. illus. diagrs. (Research rept. no. 27) [AFOSR-TN-58-439] (AF 49(638)61) AD 205519 Unclassified

This preliminary study in the field of gaseous magneto-hydrodynamics is focused on the electrical conductivity of high-temperature gases which allows the application of forces by means of rapidly changing magnetic fields. With this effect in mind, two experiments for studying the dynamic interactions of high-temperature gases with magnetic fields are described. The first experiment entails the use of an electrodeless gas accelerator. In conjunction with this, an inductive energy source is employed. The second introduces electrodes. It is concluded that the latter experiment, utilizing the above device, is more desirable than the former since: (1) the Phillips ionization gauge effect allows efficient preionization at low pressures; (2) the plasma and current-carrying gas are confined by the axial magnetic field, thus eliminating contamination from the walls; (3) the magnetic field follows the gas slug down the tube in an efficient manner, thus minimizing power requirements; and (4) more adequate time and space are available for experimental observations. Preliminary results indicate that a plasma sample has been obtained where the ion armor radius is less than the mean free path which in turn is comparable with the annular separation distances.

AVC.01:004

AVCO Manufacturing Corp. AVCO Research Lab.,
Everett, Mass.

A DESCRIPTION OF A PROPULSIVE DEVICE WHICH EMPLOYS A MAGNETIC FIELD AS THE DRIVING FORCE, by R. M. Patrick. May 1958, 8p. incl. diagrs. (Research rept. no. 28) (AFOSR-TN-58-684) (AF 49(638)61) AD 159614 Unclassified

Presented at Second Annual AFOSR Astronautics Symposium, Denver, Colo., Apr. 28-30, 1958.

Also published in *Vistas in Astronautics*, v. 2: 118-126, 1959.

A propulsion motor for space ships is described which

AVC.01:005 - AVC.01:007

produces thrust by using a magnetic field to expel a plasma. It is pointed out that the main difference between this magnetic accelerator and the ion rocket is that the magnetic device produces an electrically neutral plasma as the accelerated mass, while the ion rocket accelerates a charged mass. Experiments have been carried out using a model of this device. The results of these experiments as well as application of these results to an actual propulsion motor are discussed. A comparison between this magnetic accelerator and other means of acceleration, in particular ion rockets, is made. Furthermore, it is pointed out that the mass of the capacitors which furnish the accelerating current for the magnetic device accounts for the major portion of its total mass. (Contractor's abstract)

AVC.01:005

AVCO Manufacturing Corp. AVCO Research Lab.,
Everett, Mass.

REDUCTION OF FLIGHT TIME AND PROPELLANT REQUIREMENTS OF SATELLITES WITH ELECTRIC PROPULSION BY THE USE OF STORED ELECTRICAL ENERGY, by M. Camac. Oct. 1958, 26p. Incl. diagrs. (Research rept. no. 36) (AFOSR-TN-58-1013) (AF 49-638)61 AD 206156; PB 138439 Unclassified

Presented at Thirteenth annual meeting of the Amer. Rocket Soc., New York, Nov. 17-21, 1958.

Flight plans are analyzed for satellites having a lower thrust than the local gravitational forces. Electrical propulsion near the earth is a good example of such a system. Several missions in the gravitational field of the earth were considered and the payload mass ratio was compared as a function of the flight time when electrical propulsion is used. Two types of missions were analyzed in detail: (1) A trip from a small to a larger circular orbit and subsequent return to the earth, and (2) navigation between orbits at low altitudes. For trips starting from a low circular orbit to a larger circular orbit and subsequent return to the earth, the incorporation of electrical energy storage was shown to reduce the flight time while increasing the payload mass ratio. For making a rendezvous or similar trips at essentially the same altitude, the advantage of the electrical storage shows up quickly. The flight plans for most of these missions require that impulses be applied at only definite regions of the orbit and free flight the rest of the way. This includes missions requiring a change in the orbit plane. A transfer from a circle to an ellipse or from one ellipse to another requires that impulses be applied at limited portions of the orbit. The storage of energy permits the utilization of all the available energy thereby substantially reducing the time for a given maneuver.

AVC.01:006

AVCO Manufacturing Corp. AVCO Research Lab.,
Everett, Mass.

ELECTRIC ARC GAS HEATERS FOR RE-ENTRY SIMULATION AND SPACE PROPULSION, by T. R. Brogan. Sept. 1958, 29p. Incl. illus. diagrs. (Research rept. no. 35) (AFOSR-TN-58-1081) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-638)61 and Air Force Ballistic Missile Div. under AF 04(645)18 AD 205516 Unclassified

Presented at Thirteenth annual meeting of the Amer. Rocket Soc., New York, Nov. 17-21, 1958.

Because the available test time is limited, questions involving the exposure of materials to the high energy re-entry environment cannot be answered in contemporary quasi-steady sources of high temperature air. This paper describes the development and calibration of an arc powered wind tunnel designed to provide steady flow simulation of the conditions encountered during re-entry. Flight velocities between 16,800 and 21,800 ft/sec can be simulated with this device. The flow properties in the tunnel test section can be determined to a degree of accuracy sufficient for quantitative experiment. Use of the arc as the gas heater for an electrically propelled space vehicle is discussed. The results of a preliminary study of helium as an arc-heated propellant are presented. (Contractor's abstract, modified)

AVC.01:007

AVCO Manufacturing Corp. AVCO Research Lab.,
Everett, Mass.

A METHOD OF ACCELERATING A GAS TO HIGH VELOCITIES WITH A MAGNETIC FIELD (Abstract), by R. M. Patrick. [1958] [1]p. [AF 49(638)61] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 39, Jan. 29, 1958.

A coaxial cylindrical geometry has been used to accelerate a gas between two conducting cylinders. The acceleration mechanism works as follows. A low-frequency (1 kc) discharge through a solenoid placed around the coaxial cylinders produces a uniform magnetic field in the axial direction inside the cylinders. At the time of maximum axial field strength a discharge between the two cylinders is initiated from a condenser bank with a ringing frequency of over 200 kc. The body force due to the radial current between the two cylinders and the azimuthal magnetic field produced by the current flowing in the cylinders results in an acceleration away from the point of initial breakdown in the axial direction.

AVC.01:008 - AVC.01:010

Conditions have been produced where the mean free path for ions and electrons is longer than their gyro radius in a magnetic field, and with the mean free path small compared to the radial distance between the cylinders. Measurements have been made of the light emitted by the accelerated gas, the local magnetic field strength, the radial gas current, and the velocity of the gas.

AVC.01:008

AVCO Manufacturing Corp. [AVCO Research Lab.]
Everett, Mass.

APPLICATION OF MAGNETOHYDRODYNAMICS TO FLIGHT (Abstract), by T. [R.] Brogan, A. Kantrowitz and others. [1958] [1]p. [AF 49(638)61] Unclassified

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 288, June 19, 1958.

The interest in magnetohydrodynamics (MHD) has been spurred primarily by astrophysical problems and by problems associated with the fusion reactor. More recently it has been suggested that MHD may be applicable to high-speed flight problems. The fundamental advantage offered by MHD is that it becomes possible to exert forces on a fluid without the use of solid surfaces and hence, for example, avoid the high heat transfer encountered in hypersonic flight. The primary factor limiting the range of applicability of MHD is the magnitude of the electrical conductivity that it is possible to induce in the air stream. If one assumes conductivities corresponding to those produced by bow shock waves on an object, one can outline flight regions in which MHD devices should be superior to conventional aerodynamic shapes. These regions are of rapidly increasing importance since they include, among other things, the critical parts of satellite re-entry trajectories. The results of some preliminary calculations and experiments on MHD flow properties are also presented.

AVC.01:009

[AVCO Manufacturing Corp.] AVCO Research Lab.,
Everett, Mass.

MAGNETOHYDRODYNAMICS (Abstract), by H. E. Petschek. [1958] 2p. (Bound with its AFOSR-TR-58-125; AD 162274) (AF 49(638)61) Unclassified

Presented at Conf. on Ion and Plasma Research,
Maryland U., College Park, Sept. 30-Oct. 2, 1958.

A summary is presented of the research performed by the contractor on the fundamental properties as well as the practical applications of magnetohydrodynamics (MHD). MHD forces have been studied in argon using a conventional high temperature shock tube. Experiments on 1 and 2 dimensional flow of a gas through a magnetic field have demonstrated that lift as well as drag forces can be obtained. Preliminary investigation of arc jets and MHD generators has indicated their practical incorporation in space propulsion systems. A minimum of 50% efficiency was obtained in operating arc jets in He up to specific impulses of 1100 sec. Theoretically the MHD generator would consist essentially of a flow of hot gas with a magnetic field perpendicular to the flow. Thermal energy in the generated currents would be converted directly into electric power by electrodes. Such a generator (1) would achieve considerable increase in specific power output (for levels exceeding several megawatts), (2) could be operated at higher temperatures than a turbine generator, and thus (3) would require a smaller radiator. Theories and initial results are also presented of experiments on gas properties and MHD forces at temperatures up to 10^6 °K.

AVC.01:010

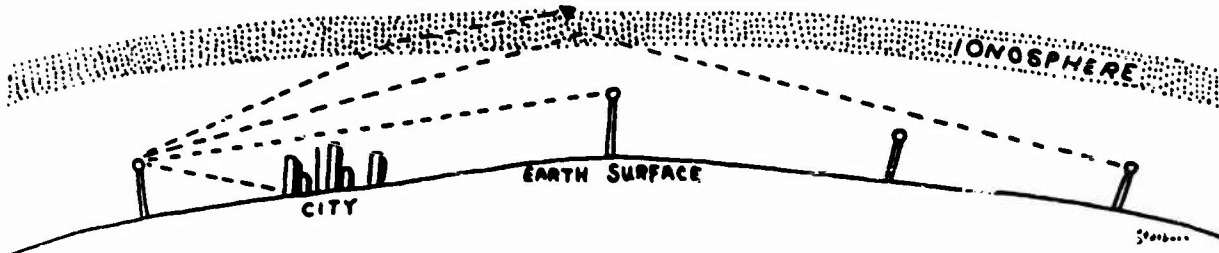
AVCO Manufacturing Corp. AVCO Research Lab.,
Everett, Mass.

PRELIMINARY EVALUATION OF HELIUM AS AN ELECTRIC ARC HEATED PROPELLANT, by T. R. Brogan. [1958] [2]p. incl. diagr. (AF 49(638)61) Unclassified

Presented at Thirteenth annual meeting of the Amer. Rocket Soc., New York, Nov. 17-21, 1958.

Published in ARS Jour., v. 29: 662-663, Sept. 1959.

Electrode and recombination losses limit the maximum specific impulses which can be produced efficiently by an arc driven propulsion device. Nevertheless, the results presented show that the helium arc can be operated so as to produce interesting values of specific impulse at reasonable conversion efficiencies.



BAN.01:005, 006; BAT.01:002, 003

BAN.01:005

[Baños, A., Jr., Los Angeles, Calif.].

TORSIONAL MAGNETO-HYDRODYNAMIC WAVES IN THE PRESENCE OF FINITE VISCOSITY, by E. Blue. Jan. 15, 1957, 95p. incl. diagrs. tables, refs. (Technical note no. 1 (Type 2)) (AFOSR-TN-57-57) (AF 18-(600)1041) AD 115096 Unclassified

The purpose of the present investigation was to carry out the solution of an idealized boundary value problem corresponding to an experiment involving the generation of a system of torsional magneto-hydrodynamic waves in liquid sodium in the presence of finite viscosity. In addition, the analysis of the solution of the problem led to the formulation and design of "ideal" experiments which would provide suitable tests of the linearized theory. The original experiment was performed in Sweden by Lehnert who obtained theoretical results based on zero viscosity. These results exhibited an apparent systematic discrepancy with experiment. In order to account for this discrepancy the theory of viscous torsional magneto-hydrodynamic waves is developed. The introduction of viscosity gives rise to a higher order differential equation and hence an additional set of modes which do not appear in Lehnert's formulation. The numerical computations are carried out on the U. C. L. A. high speed digital computer (SWAC). With the aid of SWAC, the effect of including finite viscosity as well as the effect of changing various physical and geometric parameters is studied. It is found that including viscosity in the formulation has a negligible effect. The theoretical formulation obtained in the limiting case of zero viscosity agrees with Lehnert's nonviscous formulation. However, the numerical results using Lehnert's parameters are somewhat improved by the more accurate machine computations and part of the discrepancy between theory and experiment is removed. The remaining discrepancy between the theoretical results obtained and Lehnert's experimental points is attributed to "geometric" approximations, made in formulating the idealized boundary value problem. Since the idealized boundary value problem corresponding to the proposed experiments will involve no "geometric" approximations, it is concluded that these experiments will constitute valid tests of the linearized theory. Theoretical results for these proposed experiments are obtained. (Contractor's abstract)

BAN.01:006

[Baños, A., Jr., Los Angeles, Calif.].

THEORETICAL STUDY OF MAGNETO-HYDRODYNAMIC, MAGNETO-ACOUSTIC, AND MAGNETO-ELASTIC PHENOMENA, by A. Baños, Jr. Final technical rept. May 15, 1957, 31p. incl. diagrs. (AFOSR-TN-57-35) (AF 18(600)1041) AD 126561

Unclassified

The theoretical investigation of the soluble unbounded media and boundary value problems involved in these phenomena is restricted (1) to a purely macroscopic approach to serve as a guide in the solution of the more complicated problems of plasma dynamics and (2) to a class of soluble linearized wave propagation problems. The macroscopic medium (homogeneous and isotropic) is characterized by the constant parameters μ , ϵ , and σ , where $\mu\epsilon = c^{-2}$ and σ is the (ohmic) conductivity. The modes of propagation are examined for 5 cases: (1) an ideal incompressible fluid, (2) an ideal compressible fluid subject to adiabatic processes, (3) an ideal elastic solid, (4) an incompressible fluid with finite viscosity, and (5) a compressible fluid with finite viscosity and heat conductivity. A study of the energy and momentum balance in a magneto-hydrodynamic field resulted in the derivation of a heat diffusion equation in a compressible fluid with finite viscosity and heat conductivity.

Bartol Research Foundation, Swarthmore, Pa. see Franklin Inst. Bartol Research Foundation, Swarthmore, Pa.

BAT.01:002

Battelle Memorial Inst., Columbus, Ohio.

EVALUATION OF TRANSPORT INTEGRALS FOR MIXED SCATTERING AND APPLICATION TO GALVANOMAGNETIC EFFECTS, by A. C. Beer, J. A. Armstrong, and I. N. Greenberg. Mar. 15, 1957, 24p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-57-87) (AF 18(600)1547) AD 120435 Unclassified

Also published in Phys. Rev., v. 107: 1506-1513, Sept. 15, 1957.

The Johnson-Whitwell evaluations of the conductivity integrals for mixed scattering have been extended over larger ranges of magnetic field and impurity scattering parameters to allow their application to the high-mobility semiconductors. Values are given for the first thermoelectric integral. Use of the magnetic field dependence of galvanomagnetic and thermomagnetic properties to study charge-carrier scattering is discussed. Applications of the functions in the analysis of Hall effect, Corbino magnetoresistance, and thermomagnetic phenomena as functions of magnetic field are illustrated. (Contractor's abstract)

BAT.01:003

Battelle Memorial Inst., Columbus, Ohio.

DEVELOPMENT OF HIGH-PURITY InSb AND INVESTIGATION OF BASIC ELECTRICAL TRANSPORT PHENOMENA, by A. C. Beer, R. T. Bate, and

BAT.02.001 - BAT.02.003

R. K. Willardson. Final rept. Dec. 31, 1957, 24p. incl. diagrs. refs. (AFOSR-TR-58-10) (AF 18(600)1547) AD 148078; PB 133477 Unclassified

A method was developed for measurement of the Hall effect and mobility at 80°K on InSb ingots. The method made use of 4 probes arranged in a diamond array. Two probes parallel to the ingot axis measure the resistivity voltage in the direction of current flow, and the 2 probes perpendicular to the ingot axis measure the Hall voltage. The element purification and zone-refining techniques resulted in a n-type carrier concentration in the 10^{13} /cu cm range. Total ionized impurity contents of about

1×10^{14} /cu cm (electron mobilities of 500,000 at 77°K) were obtained by a fractional reprocessing technique. Initial attempts to obtain large single crystals revealed difficulties caused by nitrides or oxides floating on the surface of the melt. An effective method was devised for eliminating the oxide from the seed by lowering the seed into molten InSb. Studies of a new thermomagnetic effect indicated that galvanometric and thermomagnetic measurements made with the specialized boundary conditions of zero transverse electric fields and thermal gradients are useful in determining (1) the mobility and concentration of the electrons and holes and (2) the position of the Fermi level with respect to the conduction and the valence band, and (3) the energy band separation in intrinsic InSb. The measurements showed promise of being a sensitive method of determining the amount of impurity or electron-hole scattering. A study was made of the magnetic field dependence of the Hall coefficient in InSb.

the weak field plateau of the Hall coefficient is determined experimentally. It has previously been pointed out that the weak field Hall coefficient as a function of the amount of ionized impurity scattering has a minimum at approximately $\beta = 0.87$, where $\beta = 6\mu_L/\mu_1$. Calculations show that inclusion of the second band increases the value of β at which this minimum occurs, and also augments its depth. These predictions are compared with the experimental data.

BAT.02:002

Battelle Memorial Inst., Columbus, Ohio.

EFFECTS OF IONIZED IMPURITY SCATTERING ON THE MAGNETORESISTANCE IN GERMANIUM (Abstract), by R. K. Willardson and A. C. Beer. [1957] [1]p. [AF 18(603)39] Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 142, Mar. 21, 1957.

The transverse magnetoresistance effect is analyzed in the region where the scattering mechanism involves both lattice vibrations and ionized impurities. The doubly degenerate valence band model is used, with neglect of the warping of the heavy mass band. Effects of anisotropy are investigated by using an ellipsoid model representative of the conduction band. Results are given in terms of impurity scattering parameters, $\beta = 6\mu_L/\mu_1$ representative of each band. The factor 6

often used in impurity scattering formulas and obtained by maximizing the non-logarithmic factor in the integrand of the conductivity transport integral in the limit of impurity scattering only is replaced by \sim . This parameter is then determined separately for each value μ_1 as well as for the Hall and the conductivity transport integrals. Results are compared with data for specimens with acceptor concentrations ranging from 10^{13} to 10^{18} /cm³ and at temperatures between 50 and 300°K. Experimental mobility values were obtained using the strong-magnetic-field limits of the Hall coefficients and the zero-field conductivities.

BAT.02:003

Battelle Memorial Inst., Columbus, Ohio.

MAGNETIC FIELD DEPENDENCE OF THE HALL COEFFICIENT IN InSb (Abstract), by R. T. Bate, R. K. Willardson and A. C. Beer. [1957] [1]p. [AF 18(603)39] Unclassified

Presented at meeting of the Amer. Phys. Soc.,

BAT.02:001

Battelle Memorial Inst., Columbus, Ohio.

EFFECTS OF IONIZED IMPURITY SCATTERING ON THE HALL COEFFICIENT IN p-TYPE GERMANIUM (Abstract), by G. L. Kendall, A. C. Beer, and R. K. Willardson. [1957] [1]p. [AF 18(603)39] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Mar. 1-2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 97, Mar. 1, 1957.

Experimental studies of the Hall coefficient in single crystals of p-type germanium were carried out in this region of mixed scattering, i.e., where the contribution of both lattice vibrations and ionized impurities must be considered. The magnitude of the impurity scattering was varied both by controlling the temperature and by using specimens of different impurity contents. In particular, data are presented for specimens with acceptor concentrations ranging from 10^{13} to 10^{18} /cm³ and at temperatures between 50 and 500°K. The data are analyzed using the two-band model as applied to hole conduction. In order to simplify calculations,

BAT. 02:004, 005; BAT. 03:001

St. Louis, Mo., Nov. 29-30, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 347, Nov. 29, 1957.

The Hall coefficient was measured as a function of magnetic field from 20 to 20 000 gauss at fixed temperatures in the region between 50°K and 300°K. The n-type InSb had carrier concentrations of about $1 \times 10^{14} \text{ cm}^{-3}$ mobilities of about $5 \times 10^5 \text{ cm}^2/\text{v-sec}$ at 50°K. The corresponding values for the p-type sample were $1 \times 10^{15} \text{ cm}^{-3}$ and $1 \times 10^4 \text{ cm}^2/\text{v-sec}$, respectively. In the extrinsic region, the variation of the Hall coefficient with magnetic field ranged between 5% and 20% for n-type samples, and between 20% and 40% for the p-type. In all samples a broad minimum occurred between 1000 and 10 000 gauss. In the intrinsic range, the variation in the Hall coefficient for the n-type specimens was about 15%. For all specimens at all temperatures used, the absolute value of the Hall coefficient was largest at low fields. Implications of the data are discussed with regard to scattering processes, quantization effects of large magnetic fields, and band structural considerations, including anisotropy and warping of the energy surfaces, and valence band degeneracy.

BAT.02:004

Battelle Memorial Inst., Columbus, Ohio.

HALL AND TRANSVERSE MAGNETORESISTANCE EFFECTS FOR WARPED BANDS AND MIXED SCATTERING, by A. C. Beer and R. K. Willardson. Dec. 30, 1957 [30]p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-58-98) (AF 18(603)39) AD 148147; PB 136193 Unclassified

Also published in Phys. Rev., v. 110: 1286-1294, June 15, 1958.

Evaluation of the transport integrals for warped electron energy bands by a method developed by McClure has been carried out for relaxation times determined by mixed scattering from acoustic phonons and ionized impurities. The analysis involves third and fifth harmonics and coefficients whose values depend on the shape of the energy surface. The Hall and transverse magnetoresistance coefficients are calculated for parameters characteristic of the degenerated valence bands in Ge and Si, as obtained from cyclotron resonance data. For Ge, results are consistent with observation in regard to a density-of-states ratio for fast and slow holes of about 4% and in the occurrence of fine structure, especially a minimum in the Hall coefficient between 1000 and 2000 gauss at 80°K, depending on the impurity content. With parameters representative of Si, substantially different behavior is predicted in line with the experiment. The Hall characteristics indicate smaller effects due to the warping than are found in Ge.

Orientation effects are not examined. The field dependence of the Hall coefficient at 196°K and 300°K could not be interpreted in terms of the model.

BAT.02:005

Battelle Memorial Inst., Columbus, Ohio.

INVESTIGATION OF THE EFFECTS OF THE VALENCE BAND DEGENERACY ON THE CONDUCTION PROCESSES IN GERMANIUM, by A. C. Beer, F. J. Reid and others. Final rept. Dec. 31, 1957, 18p. incl. diagrs. tables. (AFOSR-TR-58-9) (AF 18(603)39) AD 148077; PB 133476 Unclassified

The effects of ionized impurity scattering on the Hall coefficient in p-type Ge were studied. The experimental studies were carried out in the region of mixed scattering where the contribution of both lattice vibrations and ionized impurities are considered. The single p-type Ge crystals were 2 x 2 mm in cross section and about 1 cm long. The Hall coefficient was plotted as a function of magnetic field for a crystal with resistivities of 1 and 14 $\Omega\text{-cm}$. The effects of increased impurity scattering lowered the value of a weak-field Hall coefficient. In the comparison of experiments with theory the consistency was good to within approximately 1% in the region preceding the minimum with the choice of parameters indicated. The transverse magnetoresistance effects in p-type Ge were studied. The value of the magnetoresistance decreased with increasing impurity content at all temperatures. The transport integrals were evaluated for warped bands using the method for relaxation times determined by mixed scattering from acoustic phonons and ionized impurities. (Contractor's abstract)

BAT.03:001

Battelle Memorial Inst., Columbus, Ohio.

TRANSVERSE MAGNETORESISTANCE AND HALL EFFECT IN N-TYPE InSb, by R. T. Bate, R. K. Willardson, and A. C. Beer. July 15, 1958 [24]p. incl. diagrs. table, refs. (Technical note no. 1) (AFOSR-TN-58-641) (AF 49(638)222) AD 162173; PB 136148 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 9: 119-128, Feb. 1959.

Data on transverse magnetoresistance and Hall effect are given for fixed temperatures between 50°K and 200°K covering the range from the weak magnetic field region to the strongfield quantum limit in InSb samples of high mobility and sufficient purity that classical statistics are applicable. At weak fields, results are in semiquantitative agreement with predictions of theory based on a simple mixed scattering mechanism and a spherical conduction band. At the highest fields, the transverse magnetoresistance data approach the H/T behavior expected in the

BAT.03:002-004; BAY.01:001

basis of the quantum treatment of Argyres and Adams [Phys. Rev., v. 104: 900, 1956], and the result in the quantum limit for the purest specimen shows good agreement with the theory for reasonable values of the electron effective mass. (Contractor's abstract)

BAT.03:002

Battelle Memorial Inst., Columbus, Ohio.

HALL COEFFICIENT AND MAGNETORESISTANCE IN SEMICONDUCTING DIAMOND, by R. T. Bate and R. K. Willardson. Mar. 1, 1959, 12p. incl. diagrs. refs. (Technical note no. 2) (AFOSR-TN-58-916) (AF 49(638)222) AD 204565; PB 139918 Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Nov. 28-29, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 376, Nov. 28, 1958.

Also published in Proc. Phys. Soc. (London), v. 74: 362-367, 1959.

The Hall coefficient and transverse magnetoresistance of a pair of natural p-type semiconducting diamonds which have R_0 values of 1000 at room temperature have been measured as a function of applied magnetic field and sample temperature. A 10% monotonic increase in the Hall coefficient has been observed as the applied field increased from 500 to 20,000 gauss. This behavior is similar to that of p-type silicon and suggests a warped valence band as does the larger than expected value of the transverse magnetoresistance which has been found to vary as H^2 for applied fields below 4000 gauss. (Contractor's abstract, modified)

BAT.03:003

Battelle Memorial Inst., Columbus, Ohio.

MAGNETORESISTANCE IN InSb (Abstract), by R. T. Bate, R. K. Willardson, and A. C. Beer. [1958] [1]p. [AF 49(638)222] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 119-120, Mar. 27, 1958.

Transverse magnetoresistance of n- and p-type InSb was measured at magnetic fields between 20 and 20 000 gauss for fixed temperatures between 50°K and 300°K. The n-type InSb had carrier concentrations of $1 \times 10^{14} \text{ cm}^{-3}$, and mobilities of $5 \times 10^5 \text{ cm}^2/\text{v-sec}$ at 50°K. Corre-

sponding values for the p-type sample were $1 \times 10^{15} \text{ cm}^{-3}$ and $1 \times 10^4 \text{ cm}^2/\text{v-sec}$. In all cases, $\Delta\rho/\rho$ varied as H^2 at low fields. At low temperatures and high fields, the resistivity of the n-type samples was proportional to H/T , the parameter occurring in expressions for longitudinal magnetoresistance in the quantum limit. In no case did the resistivity saturate at high fields. The field dependence of resistivity in n-type material was less complex than that reported by others in less pure material, presumably because effects of degeneracy and magnetic field dependence of Fermi level were small. Results are correlated with data on the magnetic field variation of Hall coefficient, and are discussed with regard to scattering processes, large field quantization effects, and band structural considerations.

BAT.03:004

Battelle Memorial Inst., Columbus, Ohio.

PREPARATION AND SOME CHARACTERISTICS OF SINGLE-CRYSTAL INDIUM PHOSPHIDE, by T. C. Harman, J. I. Genco and others. [1958] [5]p. incl. illus. diagrs. [AF 49(638)222] Unclassified

Published in Jour. Electrochem. Soc., v. 105: 731-735, Dec. 1958.

A technique for purifying phosphorus, reacting elemental indium and phosphorus, purifying the compound, indium phosphide, by a directional recrystallization, and growing large crystals all in one glass tube is described. A crystal puller for decomposable solids is described in detail and results for indium phosphide discussed. The electron mobility as a function of temperature is given for two single-crystal specimens. An electron mobility of 4000 $\text{cm}^2/\text{v-sec}$ at 300°K for a specimen containing a carrier concentration of $1 \times 10^{17}/\text{cm}^3$ was achieved. Lifetime measurements by the photoconductivity-decay method are discussed. The optical-transmission characteristics of specimens containing electron concentrations of $10^{10}/\text{cm}^3$ and $10^{15}/\text{cm}^3$ are presented.

BAY.01:001

Baylor U. Coll. of Medicine, Houston, Tex.

EFFECTS OF LYSERGIC ACID DIETHYLAMIDE (LSD) ON THE TIME SENSE OF NORMALS, by W. K. Boardman, S. Goldstone, and W. T. Lhamon. Preliminary rept. [Apr. 1957] [4]p. incl. tables. (AFOSR-TN-57-201) (AF 18(603)79) AD 126498 Unclassified

Also published in A. M. A. Arch. Neurol. and Psychiatry, v. 78: 321-324, Sept. 1957.

BAY.01:002 - BAY.01:005

The estimation of one second was studied in four men before and after administration of LSD. A schizophrenia-like increase in overestimation of short durations was not found, but the coefficient of variation of three subjects increased, suggesting that temporal frames of reference tended to become vague or "lost". A double-blind study of one subject with low doses of LSD and a distilled-water placebo gave similar results: no shift in temporal concept after LSD but an increase in variability of judgment with doses as small as 4 μ . Some implications of the differences between the measures obtained with schizophrenics and with normals given LSD are discussed. Further applications of the method are suggested. (Contractor's abstract)

BAY.01:002

Baylor U. Coll. of Medicine, Houston, Tex.

THE TIME SENSE: ANCHOR EFFECTS AND APPARENT DURATION, by S. Goldstone, W. K. Boardman, and W. T. Lhamon. [1957] [9]p. incl. tables. (AFOSR-TN-57-202) (AF 18(603)79) AD 126499 Unclassified

Also published in Jour. Psychol., v. 44: 145-153, May 1957.

Anchor effects on temporal judgments of a standard physical unit, 1 sec, were studied in 121 normal subjects divided into 3 groups: short anchor (0.1 sec), long anchor (2.0 sec), and neutral anchor (1.0 sec). Judgments under all anchor conditions were influenced in the expected direction. The short anchor pulled judgments down, while the long anchor pulled judgments up. An anchor reversed condition demonstrated an interaction between past and present anchors.

BAY.01:003

Baylor U. Coll. of Medicine, Houston, Tex.

THE TIME SENSE: DIFFERENTIAL EFFECT OF SECOBARBITAL, DEXTRO-AMPHETAMINE SULFATE AND PLACEBO UPON TIME ESTIMATION MEASUREMENTS IN NORMAL SUBJECTS, by S. Goldstone, W. K. Boardman, and W. T. Lhamon. [1957] [13]p. incl. table, refs. (AFOSR-TN-57-277) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(603)79 and U.S. Public Health Service) AD 126579 Unclassified

Also published in Brit. Jour. Psychol., v. 49: 324-328, Nov. 1958 (Title varies).

[Secobarbital], dextro-amphetamine and placebo were compared with respect to changes produced in perceived duration in ninety normal subjects. A method was employed which permitted quantitative derivation of a subject's concept of 1 sec, pre-drug, 30 min post-drug and 60 min post-drug. The following findings were obtained:

(1) a significant decrease in the clock-measured value of the apparent second with the ingestion of dextro-amphetamine; (2) a significant increase in the clock-measured value of the apparent second with the ingestion of quinal barbitone; and (3) a trend toward increase in the apparent second with placebo. These findings were discussed in terms of earlier reports and a theoretical framework was offered. (Contractor's abstract)

BAY.01:004

Baylor U. Coll. of Medicine, Houston, Tex.

PSYCHOPATHOLOGY AND PSYCHOPHYSIOLOGY OF MINIMAL LSD-25 DOSAGE, by T. Greiner, N. R. Burch, and R. Edelberg. [1958] [3]p. incl. diag. (AFOSR-TN-57-377) (AF 18(603)79) AD 132451 Unclassified

Also published in A.M.A. Arch. Neurol. and Psychiatry, v. 79: 208-210, Feb. 1958.

Physiological and psychiatric changes in man from doses of lysergic acid diethylamide (LSD-25) below the normal range are presented. Seven micrograms activated the nonspecific galvanic skin response and induced cycles of rapid and profound shifts in effect. Between 7 μ g and 40 μ g the dosage response of LSD is consistent with the spectrum of psychopathology associated with the ill-defined group of "borderline" schizophrenic processes.

BAY.01:005

Baylor U. Coll. of Medicine, Houston, Tex.

DRUGS AND HUMAN FATIGUE: GSR PARAMETERS, by N. R. Burch and T. Greiner. [1958] [8]p. incl. diagr. (AFOSR-TN-57-530) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)79] and WADC Aero Medical Lab.) AD 136516 Unclassified

Presented at Norway meeting of the NATO-AGARD, May 1956.

Published in Jour. Psychol., v. 45: 3-10, Jan. 1958.

Experiments have been performed measuring fatigue by use of the GSR and illustrating shifts in GSR response patterns under prolonged wakefulness and drug-simulated fatigue. Two definite types of fatigue patterns resulted: depression and hyper-excitability. Depression often precedes or alternates with excitability, the latter being paralleled by behavioral excitability such as excessive laughter. It is also shown that prolonged stress produces both behavioral and neurophysiological manifestations of fatigue.

BAY.01:006 - BAY.01:008

BAY.01:006

Baylor U. Coll. of Medicine, Houston, Tex.

ROLE OF A SELECTIVE MEMBRANE IN THE GALVANIC SKIN REFLEX (Abstract), by R. Edelberg, T. Greiner, and N. R. Burch. [1957] [1]p. (AF 18-603)79) Unclassified

Presented at Seventy-eighth meeting of the Amer. Physiol. Soc., Chicago, Ill., Apr. 15-19, 1957.

Published in Fed. Proc., v. 16: 33, Mar. 1957.

Although the vascular and the sweat gland theories of the galvanic skin reflex have both found strong support during an unsettled 65-year controversy, the preponderance of evidence can be interpreted in favor of a membrane hypothesis. This paper offers additional evidence in support of an active membrane in the sweat gland and/or in the epidermal epithelium as the site of the changes in apparent skin resistance following both emotional and physiological stimuli. It has been shown by a system of separate but simultaneous recordings from 2 homologous sites that the GSR is profoundly influenced by the nature and concentration of the electrolyte in contact with the skin. Both resistance changes and potential changes are greatly reduced by exposure to electrode paste or low concentrations of NaCl and are greatly potentiated by exposure to CaCl₂. In contact with appropriate electrolytes, the membrane shows considerable rectifier properties and the GSR is strongly influenced by the polarity of the current. It has further been demonstrated that any resistance change produced by artificial vascular engorgement is an artefact resulting from the pressure of the engorged segment on the electrode. It is concluded that the GSR depends upon changes in the selective permeability of a negatively charged membrane whose behavior resembles that of nerve membrane.

BAY.01:007

Baylor U. Coll. of Medicine, Houston, Tex.

THRESHOLD DOSES OF LSD IN HUMAN SUBJECTS (Abstract), by T. Greiner, N. R. Burch, and R. Edelberg. [1957] [1]p. (AF 18(603)79) Unclassified

Presented at Seventy-eighth meeting of the Amer. Physiol. Soc., Chicago, Ill., Apr. 15-19, 1957.

Published in Fed. Proc., v. 16: 303, Mar. 1957.

In doses above 40 µg LSD produces behavioral alterations and florid perceptual distortions that have been well documented in human subjects. Performance of complex tasks is impossible and the model psychosis is obvious even to inexperienced eyes. Doses below 20 µg are of practical concern if gross performance is spared, but sporadic affect disorders yield ideational

and motivational impairment; on the other hand, theoretic interest is centered about the possible similarity of the threshold "model" psychosis to incipient schizophrenia. The subjects were young, nonpsychotic males, well aware of the action of LSD. A series of doses at intervals of a week ranged from 4-20 µg, along with placebo. All data were interpreted in a double-blind state. In addition to frequent psychiatric interviews, subjects made extensive notes of their attitudes and thoughts both during and after the drug effects. An adjective check list was prepared from the earlier experiences. Bioelectric recordings included frequent samples of EEG and GSR. Pupillary-iris ratios were measured from serial photographs. Severe mood swings were outstanding with an early euphoric phase followed by depressive features. Double-blind judgment about the dosage was only fair with many inversions in the ranking. Placebo was not always distinguished although ranked as the minimum effect. Alerting patterns in EEG and GSR were noted in the dose range above 10 µg. The dosage response relationships for specific disturbances of affect and thought will be described.

BAY.01:008

Baylor U. Coll. of Medicine, Houston, Tex.

RIGHT-LEFT GRADIENTS IN BODY IMAGE, BODY REACTIVITY, AND PERCEPTION, by S. Fisher. [1958] [32]p. incl. refs. (AFOGR-TN-58-1029) (Sponsored jointly by Air Force Office of Scientific Research under (AF 18(603)79) and [U. S. Public Health Service]) AD 162296 Unclassified

Also published in Genetic Psychol. Monographs, v. 61: 197-228, May 1960.

A study was made of 36 men and 42 women with a battery which embraced a wide variety of body image, body reactivity, perceptual and personality measures. Right-handed subjects who clearly experience the right side of the body as larger than the left more often manifest a GSR reactivity pattern involving greater reactivity on the left side as compared to the right side than do subjects who do not experience such a distinction. There is a significant relationship between the sex attributes assigned to the left body side and right-left GSR directionality. The greater the degree to which subjects can clearly differentiate the 2 sex roles and yet simultaneously integrate the values of both within themselves, the more likely they are to differentiate the 2 sides in the body image scheme and to manifest a left directional GSR pattern. Subjects who have mature body images are more often left GSR directional than subjects characterized by an immature body image. There are also individual right-left directionalities in perception which generalize beyond single perceptual situations. (Contractor's abstract)

BAY.01:009 - BAY.01:012

BAY.01:009

Baylor U. Coll. of Medicine, Houston, Tex.

PREDICTION OF BODY EXTERIOR VS. BODY INTERIOR REACTIVITY FROM A BODY IMAGE SCHEMA, by S. Fisher. [1958] [7]p. incl. table. (AFOSR-TN-58-1030) (AF 18(603)79) AD 162297 Unclassified

Also published in Jour. Personality, v. 27: 56-62, Mar. 1959.

Experiments have been run to determine whether individuals with definite body image boundaries are characterized by relatively high reactivity in the outer body layers and relatively low reactivity in the body interior. A group of girls 9 to 15 years of age were tested. The Rorschach test was used to evaluate boundary definiteness. GSR and heart rate were chosen to represent body exterior and body interior reactivity, respectively. Results show that the Barrier score is positively correlated with no. of GSR responses ($r = +.31$, $p < .10$) and negatively correlated with heart rate ($r = .19$).

BAY.01:010

Baylor U. Coll. of Medicine, Houston, Tex.

A DEVELOPMENTAL ANALYSIS OF SOME BODY IMAGE AND BODY REACTIVITY DIMENSIONS, by S. Fisher and R. L. Fisher. [1958] [14]p. incl. table, refs. (AFOSR-TN-58-1031) (AF 18(603)79) AD 162298 Unclassified

Also published in Child Development, v. 30: 389-402, 1959.

The study concerns the relationship between body image concepts of the right and left body sides and the relative Galvanic skin response (GSR) reactivity of the two sides. 119 right-handed subjects from 5 to 17 years were tested. Anisokonic lenses, puppets, Rorschach responses and the Thematic Apperception Test were employed. Results indicate (1) left directional reactivity is rare in right-handed persons until adolescence; (2) only chance relationships exist between body image measures and right-left reactivity patterns before adolescence; (3) effective differentiation in the right-left body image axis depends somewhat on parental models exemplifying well defined sex roles; and (4) a more complex system for disposition of excitation arises at adolescence.

BAY.01:011

Baylor U. Coll. of Medicine, Houston, Tex.

EXTENSIONS OF THEORY CONCERNING BODY IMAGE AND BODY REACTIVITY, by S. Fisher. [1958] [8]p. incl. refs. (AFOSR-TN-58-1032) (AF 18(603)79) Unclassified

Also published in Psychosomatic Med., v. 21: 142-149, Mar.-Apr. 1959.

Previous research findings have indicated that important socialization experiences may become translated into body image attitudes and these in turn into body reactivity gradients or landmarks. On this basis a theory is offered that proposes that many of the crucial roles learned by the individual need to be transposed into body attitudes before they can become an integral part of his identity. A further formulation is offered that views many psychosomatic symptoms as representing distorted attempts by individuals under stress to maintain fading body excitation landmarks whose existence have considerable reassurance value. (Contractor's abstract)

BAY.01:012

Baylor U. Coll. of Medicine, Houston, Tex.

POSSIBLE SENSITIZING OF TACTILE RECEPTORS BY THE GALVANIC SKIN REFLEX (Abstract), by R. Edelberg and N. R. Burch. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under (AF 18(603)79) and National Institute of Mental Health) Unclassified

Presented at Eightieth meeting of the Amer. Physiol. Soc., Philadelphia, Pa., Apr. 14-18, 1958.

Published in Fed. Proc., v. 17: 39, Mar. 1958.

The electrical changes of the GSR may be in part a by-product of the sensitizing of tactile receptors by sympathetic discharge. Tactile sensitivity in humans was measured with a vibratory stimulus of 250 cps, GSR with a constant current system. After a delay of 5-20 sec following the onset of a GSR attending emotional or sensory stimulation, there is a conspicuous increase in tactile sensitivity which then gradually decays unless further GSRs occur. The amount of change in threshold is proportional to the amplitude of the GSR but tactile sensitivity is not correlated with basal resistance per se. This change is observable either in the dry state or under water and therefore cannot be due to the skin-softening action of sweat as proposed by Darrow. Survey of the hand and forearm shows a high topical correlation between tactile sensitivity and GSR activity in regions having similar innervation. The temporal and spatial relations are consistent with the hypothesis that both the galvanic changes and the threshold changes are common effects of the release of a chemical mediator which takes longer to diffuse to the tactile receptors than to the membrane responsible for the skin's resistance. A delayed adrenal effect may be involved as well.

BEL.01:003, 004; BRM.01:001;
BJO.01:006

BEL.01:003

Bell Aircraft Corp. [Rocket Engine Dept.] Buffalo, N. Y.

PROGRAM OF EXPLORATORY RESEARCH ON ROCKET ENGINE COMBUSTION, by T. G. Rossmann. Final rept. Sept. 15, 1956-Sept. 14, 1957. Oct. 15, 1957, 75p. incl. illus. diagrs. tables, refs. (Rept. no. 02-982-026) (AFOSR-TR-58-17) (AF 18(600)1156) AD 148132; PB 136418 Unclassified

Research performed during the report period consists of two phases. Phase B is a study of the liquid phase reaction between rocket propellants. Results of FNA/hydrocarbon mixing studies indicate that IW FNA can be used in place of WFNA but that red and white acids cannot be used interchangeably. Spectrophotometric methods and qualitative organic analyses were used to identify FNA/hydrocarbon reaction products, to deduce the reaction sequence and to estimate the extent of the reaction. Phase D is the observation of burning propellants in rocket engines. Details considered are (1) a windowed motor, (2) the development of a new high-speed flashing unit, (3) a single-sweep mirror camera, and (4) illuminating optics and filters.

BEL.01:004

Bell Aircraft Corp. Rocket Engine Dept., Buffalo, N. Y.

A HIGH SPEED STRIP CAMERA FOR ROCKET CHAMBER RESEARCH, by K. R. Stehling, J. L. Freeland, and R. Schmidt. [1958] [11]p. incl. illus. diagrs. (AF 18-600)1156) Unclassified

A camera, developed at the Bell Aircraft Corporation for the photography and measurement of events occurring within a rocket thrust chamber, is described. It is a continuous "strip" device having no provision for separation of the images. The optical train consists of an f/2.5, 178 mm f.l Aero Ektar photographic lens which focusses the light on a 2-in. by 2-in. front-surface aluminized mirror. The mirror-actuating mechanism, details of which are presented, allows the mirror to sweep through a 40° arc at a rate of 20°/msec, giving a writing speed of approximately 1000 ft./sec. A Packard G iris shutter is placed in front of the lens to prevent light from entering the lens aperture before and after an exposure is made. It is pointed out that the opening and closing of the shutter can be synchronized with the beginning and end of the mirror's travel, and the mirror in turn can trigger photoelectrically the external flashing light source. Tests using this camera have shown that it can resolve and photograph small droplets traveling at high velocities. The mirror mechanism is rugged and dependable, and the mirror's speed is reasonably linear. The useful depth of field at 4x magnification is approximately 0.1 in., and the maximum resolving power is calculated to be 425 lines/mm.

BRM.01:001

Birmingham U. Dept. of Physical Metallurgy (Gt. Brit.).

THE MIGRATION OF GRAIN BOUNDARIES IN METALS UNDER THE INFLUENCE OF A TEMPERATURE GRADIENT, by R. W. Cahn and R. W. Lucas. Technical summary rept. Oct. 1956 - Oct. 1958, 1v. incl. illus. diagrs. refs. (AFOSR-TN-58-1056) (AF 61(514)1020) AD 206941; PB 146844 Unclassified

An exploratory investigation of temperature gradient induced grain boundary migration was made to further the knowledge of the structure of high angle boundaries, the structure of grain boundaries at high temperature, and modification of these structures by the presence of solute atoms. An apparatus with a constant temperature bath, capable of producing a range of temperature gradients, was constructed. Large grained polycrystalline specimens of Zn were used for the experiments on grain boundary migration. Results on Zn specimens indicate that it is necessary to have a certain concentration of impurities at the boundary, and the boundary must be at a temperature within a few degrees of the melting point. These deductions are compatible with previous observations on Al. In the case of very high temperatures and low impurity concentrations, impurities not only increase the rate of grain boundary migration but appear to be an essential cause of it. (ASTIA abstract)

BJO.01:006

Bjorksten Research Foundation, Madison, Wis.

STUDY OF CROSS LINKAGES IN GELATIN, by H. L. Gottlieb and J. Bjorksten. Final research rept. Mar. 1957, 75p. incl. tables. (AFOSR-TR-57-26) (AF 18(600)-1010) AD 126444 Unclassified

A study is being made of the effect of cross linking agents on the susceptibility of gelatin to enzymatic hydrolysis. It is definitely shown that the enzymatic hydrolysis is interfered with by cross linking agents. The work covers chromium, formaldehyde and p-benzoquinone as cross linking agents. Amino acids in the hydrolysate were determined by chromatography. The possible error is quite large, and it was therefore necessary to accumulate an amount of data sufficient for statistical analysis. While certain amino acids seem to be blocked more than others, in a large number of tests, it is believed that a separate pinpointed study will be necessary to determine the specific linkages involved. The present broad study may prove useful in aiding to select promising areas for pinpointing. Data were obtained on the effect of preceding ionizing radiation on the hydrolysis of gelatin. While a few of the series seem to indicate a possibility of some effects, the fluctuations and variability in results preclude conclusions, except possibly after further statistical

BJO. 01:007; BJR. 01:001;
BOS. 04:001; BOS. 02:009

study. Since radiation causes breakage of chains as well as cross linkages, composite effects are to be dealt with in these cases. (Contractor's abstract)

BJO.01:007

Bjorksten Research Foundation, Madison, Wis.

A COMMON MOLECULAR BASIS FOR THE AGING SYNDROME, by J. Bjorksten. [1958] 18p. incl. diagrs. refs. (AF 18(600)1010) Unclassified

Also published in Jour. Amer. Geriatrics Soc., v. 6: 740-748, Oct. 1958.

While the manifestations of aging are many, there are certain underlying phenomena which they all have in common. The clinical symptoms of degenerative diseases have been observed and by the use of histological technique definite microscopic changes were found. The chemical processes underlying these changes have not been properly elucidated. With advancing age, there is a slowing in metabolism, a loss of elasticity of the tissues, an increasing brittleness in bone and cartilage, a loss of water binding capacity, and above all, a reduced resistance to disease and to trauma of all kinds. A curve, which is based on the mortality rate from the total US population, shows the reduced resistance.

BJR.01:001

Bjorksten Research Labs., Inc., Madison, Wis.

QUARTZ FIBERS IN HIGH TEMPERATURE RESISTANT MATERIALS, by W. S. Fiedler, B. A. Cash and others. Final rept. May 1, 1956-May 31, 1958, 71p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-91) (AF 18(603)42) AD 162132 Unclassified

The continuous production of vitreous silica fiber by cane drawing and drawing from a bushing was studied. Drawing from cane gave the most rapid development of a method for producing single vitreous silica fibers. Fibers were drawn to a fineness of 8μ. Fibers 20μ in diameter were successfully coated with metallic Al and Ag. Hot-pressed laminates were made from the Al-coated samples. A method of heating the cane for drawing was developed to utilize a carbon resistor surrounding the tip of the cane which allowed for close temperature control. The life of the carbon resistor, although limited, was sufficient to allow the drawing of one length of cane at a time. The development of bushing spinning resolved itself into a problem of protecting the high melting metals (Mo, Nb, Ta, and W) from the effects of high temperature oxidation. Progress was made toward the development of an inert gas shield for these bushings. Special measuring techniques indicated that tensile strengths of the fibers produced from cane in the 20-μ range were in the range of 75,000 to 400,000 psi. The

coating technique of drawing the fibers through molten Al did not degrade the tensile strength of these fibers. Dense, well-appearing laminates could be produced from these Al fibers. (ASTIA abstract)

BOS.04:001

Boston U. Dept. of Biology, Mass.

A DEVICE FOR SIMULTANEOUS MICROSCOPIC OBSERVATION OF PERIPHERAL AND VISCERAL CIRCULATION, by K. A. Arendt. [1957] 9p. incl. illus. diagr. (AFOSR-TN-57-800) (AF 49(638)44) AD 148034 Unclassified

Also published in Proc. Exper. Biol. Med., v. 97: 12-14, 1958.

A method is described for simultaneous comparison and photographic recording by still or motion pictures of the microcirculation in two different areas of the same animal. The apparatus consists of a field-splitting device which is placed over the oculars of two microscopes adapted at present for use with cheek pouch and the mesoecum of the golden hamster. (Contractor's abstract)

BOS.02:009

Boston U. [Dept. of Physics] Mass.

NEUTRONS FROM THE HE^3 BOMBARDMENT OF B^{10} , by F. Ajzenberg-Selove, M. L. Bullock, and E. Almquist. [1957] [24]p. incl. diagrs. table, refs. (AFOSR-TN-57-445) (Sponsored jointly by Air Force Office of Scientific Research under [AF 10(600)997], Atomic Energy Commission and Atomic Energy of Canada, Ltd.) AD 136435 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 28, Jan. 30, 1957.

Also published in Phys. Rev., v. 108: 1284-1288, Dec. 1, 1957.

The neutron spectrum from the $B^{10}(He^3,n)N^{12}$ reaction has been studied at bombarding energies of 2.54 and 3.60 mev by the method of proton recoils in nuclear emulsions. The Q value of the reaction has been measured to be 1.46 ± 0.06 mev. The mass of N^{12} is found to be 12.02255 ± 0.00007 amu. The data also indicate excited states of N^{12} at 1.06 ± 0.08 , 1.56 ± 0.08 , (1.97 ± 0.010) , 2.35 ± 0.08 , 3.18 ± 0.015 , and 3.46 ± 0.15 mev, in good agreement with the known levels of the mirror nucleus, B^{12} . At the bombarding energy of 2.54 mev, the center of mass angular distribution of the ground

BOS.02:010-012; BOS.03:004

state neutrons is isotropic, while at 3.60 mev, the angular distribution is peaked forward so that the ratio $I(0)/I(140) = 2.9 \pm 0.7$. (Contractor's abstract, modified)

BOS.02:010

Boston U. [Dept. of Physics] Mass.

ANGULAR DISTRIBUTIONS OF NEUTRONS FROM

$Al^{27}(d,n)Si^{28}$, by A. G. Rubin. [1957] 22p. diagrs. refs. (AFOSR-TN-57-446) [AF 18(600)997] AD 136436
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 233-234, Apr. 25, 1957.

Also published in Phys. Rev., v. 108: 62-68, Oct. 1, 1957.

By using the method of proton recoils in nuclear emulsions, angular distribution of neutrons emitted to low-lying states of Si^{28} in the reaction $Al^{27}(d,n)Si^{28}$ have been obtained at deuteron energies of 2.16 and 6.00 mev. As might be expected, the angular distributions obtained at $E_d = 2.16$ mev show considerable deviations from the predictions of the simple Butler stripping theory. The angular distributions obtained at $E_d = 6.00$ mev have been analyzed by means of the Butler theory to obtain parities and limits on the spins of Si^{28} states. These results are, for the ground state, $J^\pi = 0^+, 1^+, 4^+$, or 5^+ ; 1.78-mev state, $J^\pi = 2^+$ or 3^+ ; 4.62-mev state, $J^\pi = 1^-$ to 4^- ; 8.24-mev state, $J^\pi = 2^+$ or 3^+ ; 6.88-mev state, $J^\pi = (1^- \text{ to } 4^-)$; 7.90-mev state, $J^\pi = 2^+$ or 3^+ ; 8.57-mev state, $J^\pi = 2^+$ or 3^+ ; 9.39-mev state, $J^\pi = 2^+$ or 3^+ . It is pointed out that the odd parity of the 4.62-mev state of Si^{28} is consistent with the possible shell-model states of a spheroidal nucleus. (Contractor's abstract)

BOS.02:011

Boston U. [Dept. of Physics] Mass.

AN EXPERIMENTAL STUDY OF THE REACTION

$Al^{27}(d,n)Si^{28}$, by A. G. Rubin. 1957, 131p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-636) (AF 18-(600)997) AD 136623; PB 137528
Unclassified

The neutron spectrum and angular distributions of neutron groups from the reaction $Al^{27}(d,n)Si^{28}$ were obtained by the method of proton recoils in nuclear emulsions. A thin Al target was bombarded with 2.16-mev deuterons from the M.I.T. Rockefeller

Van de Graaff generator. Neutrons were detected by means of 400- μ Ilford C-2 emulsions placed at 9 angles to the incident beam. The plates were scanned with a Leitz binocular microscope equipped with a moving stage, at 1000 magnification. Neutron spectra were obtained at 8 angles from 0° to 120° . A total of 12,500

tracks was scanned. Excited states of Si^{28} were obtained from these measurements from 1.78 ± 0.10 to 10.25 ± 0.06 mev. The cross-section for formation of the 9.37 state of 0^+ is 10.1 millibarns per steradian, within a factor of 2. A second bombardment for the same reaction was made with a bombarding energy of 6.00 mev to obtain valid stripping angular distributions; emulsions were placed at 9 angles to the incident beam, at 15° intervals, from 0° to 135° . The angular distributions which were obtained were compared with the Butler stripping theory to obtain the parities and limits on the spins of the states in Si^{28} which were reached in the reaction. A thin target of isotopic B was bombarded with 7.03 mev protons. The neutrons from the $B^{11}(p,n)C^{11}$ reaction indicated an excited state of C^{11} at 2.01 ± 0.08 mev. The reaction $P^{31}(p,n)S^{31}$ was studied at $E_p \pm 17.2$ mev. The energy spectrum of the neutrons was determined by means of proton-recoil measurements in nuclear emulsions. The mass excess ($M - A$) of S^{31} was calculated to be -10.04 ± 0.20 mev. Excited states of S^{31} were located at 1.15 ± 0.15 , 2.28 ± 0.20 , 3.35 ± 0.20 , 4.51 ± 0.15 , 5.94 ± 0.30 , and 6.41 ± 0.20 mev.

BOS.02:012

Boston U. Dept. of Physics, Mass.

[NEUTRON ENERGIES FROM NUCLEAR PLATE MEASUREMENTS], by F. Ajzenberg-Selove. Final quarterly progress rept. no. 18, Sept. 30, 1957 [8]p. incl. diagrs. (AFOSR-TR-57-68) (AF 18(600)997) AD 136596
Unclassified

The report contains lists of staff members, progress reports, publications and published abstracts, theses, and papers presented at meetings during the period of the contract.

BOS.03:004

Boston U. Dept. of Physics, Mass.

THE LANGEVIN EQUATION AND THE H THEOREM (Abstract), by A. Siegler. [1957] [1]p. (AF 18(603)29)
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 23, Jan. 30, 1957.

BOS.03:005, 006; BRU.01:001

The Langevin equation, $\ddot{\alpha} + \gamma\dot{\alpha} = a(t)$, where γ is a constant and $a(t)$ is the derivative of the Wiener random function, gives probability distributions for $\alpha(t)$ that are symmetrical in time. Nonetheless, the sample functions show an exponential decay if the initial value of α is fixed. The set of curves $\alpha(t)$ is ergodic; this follows from the ergodicity of the Wiener function. Physically this means that its probability distributions could be duplicated by a set consisting only of a single suitably constructed infinite curve and all those curves obtainable from it by time displacement (all values of time displacement being equally weighted). From the time symmetry of the distributions one can infer that there is no difference between the essential structure of this curve and that obtained from it by reversing the time. Almost all of the curves of the set are H curves, reconciling time reversibility with the overwhelming tendency of systems to approach equilibrium. These remarks lend themselves readily to graphical demonstration.

BOS.03:005

Boston U. Dept. of Physics, Mass.

QUANTUM EFFECTS IN BROWNIAN MOTION, by H. Goldring and A. Siegel. June 26, 1957, 19p. incl. diagrs. tables, refs. (AFOSR-TN-58-345) (AF 18(603)29) AD 158616

Unclassified

The equations of motion of particles in a random process are given by the Langevin equation $\ddot{x} + c\dot{x} = F(t)$, where $F(t)$ is the random force acting on the particle. This random force is prescribed by means of a spectral distribution function which in the classical case is proportional to kT and in the quantum mechanical case is proportional to $\hbar\omega/e^{\hbar\omega/kT} - 1$, where $a = \hbar\omega/kT$. The correlation functions of the particle velocity in the random process are calculated for the classical and quantum mechanical cases in order to investigate the possible manifestations of quantum effects and their magnitude. A method for calculating the correlation function for the particle displacement is also indicated. It is shown that the force spectrum is independent of the statistics of the colliding particles if the process is regarded as an additive one, i.e., if the time of collision is neglected.

BOS.03:006

Boston U. Dept. of Physics, Mass.

STOCHASTIC BASIS OF THE EULERIAN VARIATIONAL PRINCIPLE IN LINEAR DISSIPATIVE PROCESSES, by A. Siegel [1957] [7]p. [AFOSR-TN-58-345a] [AF 18-(603)29]

Unclassified

Also published in Phys. Rev., v. 106: 609-615, May 15, 1957.

The application of the Eulerian variational method to the Onsager Lagrangian of a linear dissipative process implies that variables undergoing strong spontaneous fluctuations (i.e., following curves other than the characteristic exponential decay from a given initial value) obey, on a macroscopic time scale a simple differential equation which also describes the more usual exponential decay curve. To justify this from the stochastic model of such processes in which the variable obeys the Langevin equation, requires that two things be proved: (1) as a necessary condition, that the stochastic curves under the given conditions do indeed cluster strongly about the solution of the differential equation; (2) as a sufficient condition, that the approximate time integral (actually obtained as a finite sum) of the Onsager Lagrangian be close to its relative minimum, for a time subdivision that is fine in the macroscopic sense. (1) is proved by deriving the conditional probability density of the Langevin variable at a time intermediate between two other times from the values of the variables at these times. The proof of (2), which utilizes this distribution function, follows lines similar to the more special case previously treated by the author. (Contractor's abstract)

BRU.01:001

Brandeis U. [Dept. of Physics] Waltham, Mass.

LINEARIZED BOUNDARY PROBLEMS IN KINETIC THEORY (Abstract), by S. Ziering and E. P. Gross. [1957] [1]p. [AF 49(638)27]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 203 Apr. 25, 1957.

The steady flow of a gas between two parallel plates is investigated by solving the linearized Boltzmann equation with the distribution function subject to simple microscopic boundary conditions. Examination of the low-pressure limit shows the essentially discontinuous nature of the distribution in velocity. To satisfy boundary conditions, one should distinguish between velocities directed towards and away from a solid. Accordingly, Yvon's method in radiative transfer theory is followed, and expansion is undertaken of each section of the distribution in polynomials orthogonal over the respective half of the velocity range. The space dependent coefficients satisfy a set of linear differential equations. This technique is applied to the problems of shear flow and heat conduction to obtain solutions valid for arbitrary ratios of mean free path to plate separation. Linearization restricts the validity to low speeds and small temperature differences. Numerical results are obtained for inverse fifth and hard sphere molecules. Rapid convergence over the entire pressure region is a direct consequence of strict embodiment of the discontinuous feature. The lowest approximation agrees with high

BRU.01:002 - BRU.01:005

approximations of the slowly convergent full range methods of Chang and Uhlenbeck and Mott-Smith.

BRU.01:002

Brandeis U. [Dept. of Physics] Waltham, Mass.

THEORY OF THE POLARON (Abstract), by E. P. Gross and C. Willis. [1957] [1]p. [AF 49(638)27] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 186-187, Apr. 25, 1957.

A study is made of the energy spectrum and eigenfunctions of the polaron Hamiltonian, for which the interaction of electron and lattice vibrations is linear in the creation operator α_k^+ and the annihilation operator α_k of the lattice quanta. The unitary transformation $u = e^s$ is introduced, where $s = \sum_k \{ \alpha_k \phi_k^*(q) - \alpha_k^+ \phi_k(q) \}$ for which the $\phi_k(q)$ depend on the electron coordinate q and also contain parameters representing averages over the electron state. The new lattice coordinates are measured with respect to a weighted function of instantaneous and average electron coordinates which depends on the coupling strength. The transformed Hamiltonian is found to be a quadratic form in α_k and α_k^+ . The trial functions $\psi(q) \phi(\alpha_k^+ \alpha_k)$ are used in order to obtain the lowest energy state. If ϕ represents the vacuum state, and ψ is a plane wave, and $\phi_k(q)$ depend only on the instantaneous electron coordinate, then the procedure leads to the intermediate coupling theory. If ϕ is localized and $\phi_k(q)$ depends only on average electron state then the strong limit is obtained. With more general ϕ_k , ψ , ϕ the physical effects of the small oscillation theory are obtained and an accurate description of the transition region is derived. The results are readily generalized to the case of many electrons.

BRU.01:003

Brandeis U. [Dept. of Physics] Waltham, Mass.

UNIFIED THEORY OF INTERACTING BOSONS, by E. P. Gross. [1958] 12p. (Technical note no. 1) (AFOSR-TN-58-509) (AF 49(638)27) AD 158320 Unclassified

Published in Phys. Rev., v. 106: 161-162, Apr. 1, 1957.

A method is outlined which is supposed to apply to the

calculation of the energy spectrum of helium in the solid and in the liquid state. The equations of motion for the quantized amplitudes are at first solved for classical amplitudes; from the solutions, inferences are made regarding the solution of the original problem.

BRU.01:004

Brandeis U. [Dept. of Physics] Waltham, Mass.

CLASSICAL THEORY OF BOSON WAVE FIELDS, by E. P. Gross. [1958] 21p. (Technical note no. 2) (AFOSR-TN-58-510) (AF 49(638)27) AD 158321 Unclassified

Also published in Ann. Phys., v. 4: 57-74, May 1958.

The subject of discussion is the Hamiltonian for a system of bosons interacting by two body forces, as expressed in the formalism of second quantization. In this paper, we examine properties of the classical wave field governed by the Hamiltonian. For a general potential there is always an exact solution representing a uniform density. Exact solutions are exhibited, which represent disturbances of a definite velocity and of arbitrary amplitude. For small amplitudes the disturbances obey Bogolyubov's dispersion relation. Corresponding exact solutions are found for disturbances when the system moves as a whole. For suitably attractive potentials we find a class of exact solutions, degenerate in energy, with spatially periodic density. These solutions have a lower energy than the uniform type. Small amplitude excitations are investigated for the periodic case. They are phonons for long wave lengths, but show a band character at shorter wave lengths. A theory of the motion of foreign atoms in the boson fluid is formulated. (Contractor's abstract)

BRU.01:005

Brandeis U. [Dept. of Physics] Waltham, Mass.

KINETIC THEORY OF LINEAR SHEAR FLOW, by E. P. Gross and S. Ziering. [1958] [10]p. incl. diagrs. (Technical note no. 3) (AFOSR-TN-58-511) (AF 49(638)27) AD 158322 Unclassified

Also published in Phys. Fluids, v. 1: 215-224, May-June 1958.

The flow of a monatomic gas between two parallel plates kept at the same temperature and moving in opposite directions is studied. The relative velocity of the plates is much smaller than the speed of sound. The deviation from the equilibrium distribution, $\phi(c, x)$, satisfies the linearized Boltzmann equation. The customary boundary conditions are adopted in which a fraction of the molecules is specularly reflected and the rest emitted with a Maxwellian distribution characteristic of the plate. The

BRU.01:006 - BRU.01:008

method consists of setting $\phi = \phi^+$ for $c_x > 0$ and $\phi = \phi^-$ for $c_x < 0$ so that positive and negative velocities are distinguished. We take $\phi^\pm = a_0^\pm(x)c_z + a_1^\pm(x)c_z c_x$. The space functions are determined by taking half-range velocity moments of the Boltzmann equation. Explicit results for the distribution function, flow velocity and stress are given for a general law of force. Numerical results are worked out for hard sphere molecules. The method treats both microscopic boundary conditions and conservation laws exactly. Precise results are obtained both for the low-pressure region and for the high-pressure coefficient of viscosity. The region of slip flow is analyzed. Maxwell's slip condition is remarkably close to the condition obtained here from the kinetic theory. In this region of pressures, the deviations from the velocity profile of the hydrodynamic slip flow theory are everywhere very small, and are completely negligible at distances greater than $1/8$ of a mean free path from a plate. (Contractor's abstract)

BRU.01:006

Brandeis U. [Dept. of Physics] Waltham, Mass.

RAYLEIGH'S PROBLEM AND KINETIC THEORY OF GASES (Abstract), by E. A. Jackson and E. P. Gross. [1958] [1]p. [AF 49(638)27] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 65, Jan. 29, 1958.

The problem of an infinite plate in a gas set impulsively into uniform motion along its plane is studied. We seek solutions of the linearized Boltzmann equation appropriate to the case when the speed of the plate is less than the sound speed. The accurate description of the gas depends on distinguishing between the molecules which are impinging on, or leaving, the plate. In order to do this we use Yvon's method of half-range distribution functions previously used to study the Couette flow problem for all values of density. This method enables us to satisfy the boundary conditions and thereby obtain exact results for both long and short times. With the problem formulated in terms of half-range distribution functions, it is necessary to use only a few velocity polynomials to obtain excellent results. Comparing the results with those based on the Navier-Stokes theory and by Grad's thirteen moment method, it is found that they become inaccurate for times less than the collision period.

BRU.01:007

Brandeis U. [Dept. of Physics] Waltham, Mass.

THEORY OF NONLINEAR BOSON FIELDS (Abstract),

by E. P. Gross. [1958] [1]p. [AF 49(638)27]

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 54, Jan. 29, 1958.

The Hamiltonian is studied for nonrelativistic interacting bosons (such as helium atoms) written in the formalism of second quantization. The approach is based on an analysis of exact solutions of the associated classical equations of motion. There is always a solution in which the wave field is spatially uniform; for a purely repulsive potential this is the lowest energy solution. Solutions are found which represent large amplitude disturbances which for small amplitudes satisfy the Bogolyubov relation between frequency and wave vector. For a potential with a sufficiently strong attractive part, there is a spatially periodic solution. This is shown to be the appropriate solution for liquid helium. The associated disturbances have phonon character for long wavelength but the spectrum has a band character at short wavelengths. A procedure is given for finding corresponding quantum wave functions. A variety of problems, such as the behavior of the boson fluid in a rotating cylinder, flowing through a pipe, propagating disturbances on a carrier background, is solved by investigating the solutions of the classical fluid with appropriate boundary conditions.

BRU.01:008

Brandeis U. [Dept. of Physics] Waltham, Mass.

KINETIC THEORY OF THE IMPULSIVE MOTION OF AN INFINITE PLANE, by E. P. Gross and E. A. Jackson. [1958] [11]p. incl. refs. [AF 49(638)27] Unclassified

Published in Phys. Fluids, v. 1: 318-328, July-Aug. 1958.

The half-range method of solution of the Boltzmann equation is used to give a kinetic theory treatment of the Rayleigh problem. In contrast to the Navier-Stokes or Grad theories, the method yields exact results for the initial stress and slip velocity at the boundary. It also indicates corrections to the classical Rayleigh results, even at long times compared to the collision periods of the gas molecules. The corrections are shown to be related to the usual slip boundary conditions of hydrodynamics plus an additional part arising from boundary layer effects. The half-range method predicts corrections to the standard methods of between 10%-25% for all values of the time. (Contractor's abstract)

BIR.001; BRI.01:005-008

BIR.01:001

Breda Istituto di Ricerche Scientifiche Applicate all' Industria, Milan (Italy).

RESEARCH ON THE INFLUENCE OF ULTRASONIC WAVES ON METALLIC CORROSION, by A. Reggiori and T. Songa. Nov. 15, 1956, 1v. incl. illus. diagrs. tables. (Rept. no. 2371) (AFOSR-TR-57-3) (AF 61-514)873) AD 115033 Unclassified

Literature on the effects of ultrasonic waves on corrosion was surveyed. Equipment and techniques were developed to make corrosion tests on metals in (1) stagnant solutions, (2) solutions with ultrasonic waves, (3) solutions with mechanical agitation, and (4) solutions with mechanical agitation and ultrasonic waves. The ultrasonic waves were imparted by a quartz transducer to the solution in which the corrosion specimens were immersed. The corrosion was measured by the potential of the sample under test against a saturated calomel electrode and by the determination of the total Fe dissolved in the attacking solution in the course of the test. Ni-Cr 18-8 stainless steel and Armco Fe were submitted to corrosion tests with the use of N HCl and N/100 HCl, respectively, in the different conditions of the solutions. Corrosion tests were also made, in the same conditions and on the same materials, but with the solutions saturated with pure N or with pure O instead of air. The influence of the ultrasonic waves on the corrosion of the stainless steel and Armco Fe was studied. The presence of ultrasonic waves in the electrolyte increases the rate of corrosion on both steels. The tests with gas saturated solutions showed that this action of the ultrasonic waves is connected with the presence of O in the attacking solution. A magnetostrictive ultrasonic wave generator was built for work on corrosion with the use of ultrasonic waves of different energy and frequency and different electrolytes.

BRI.01:005

Brigham Young U. Dept. of Chemistry, Provo, Utah.

THE CATALYTIC HYDROGENATION ACTIVITY OF RHENIUM BLACKS PRODUCED BY THE ACTION OF SODIUM BOROHYDRIDE ON AMMONIUM PERRHENATE AND OF TETRAHYDROPYRAN ON RHENIUM HEPTOXIDE, by J. H. Johnson. Oct. 1956, 99p. incl. tables. (AFOSR-TN-58107) (AF 18(600)1164) AD 152016 Unclassified

A study was made of the catalytic activities of two rhenium compounds on the hydrogenation of various organic substances. It was found that the activity of the catalyst Re_2O_3 was generally equal to or greater than that for previously studied rhenium catalysts. The second catalyst, obtained from the reaction of tetrahydropyran with rhenium heptoxide, exhibited unique properties in that benzene was hydrogenated with

greater ease than nitrobenzene. It was found that both catalysts were much more active than platinum or Raney nickel in reducing acetic acid.

BRI.01:006

Brigham Young U. Dept. of Chemistry, Provo, Utah.

THE PREPARATION AND CATALYTIC PROPERTIES OF RHENIUM BLACKS OBTAINED BY REDUCTION OF Re(VII) IN ANHYDROUS AMMONIA AND AMINES WITH ALKALI METALS, by D. W. Seegmiller. Sept. 3, 1957, 125p. incl. diagrs. tables, refs. (AFOSR-TN-58-108) (AF 18(600)1164) AD 152017 Unclassified

The catalytic activities of rhenium blacks prepared from the reduction of rhenium salts in alkali metal ammonia or amine systems is studied. In general the activity of the lithium ethylamine catalyst was found to be superior to that of catalysts prepared in ammonia. It is concluded that the catalysts are most useful in their ability to catalyze the reduction of carboxylic acids.

BRI.01:007

Brigham Young U. Dept. of Chemistry, Provo, Utah.

RHENIUM CATALYSIS: I. HYDROGENATION AND HYDROFORMYLATION USING RHENIUM CARBONYL COMPOUNDS. II. HYDROGENATION USING CATALYSTS OBTAINED FROM THE REDUCTION OF PERRHENATES WITH METALS IN AQUEOUS SOLUTION, by T. G. Selin. Sept. 1957, 85p. incl. tables. (AFOSR-TN-58-109) (AF 18(600)1164) AD 152018 Unclassified

The catalytic activities of rhenium pentacarbonyl, rhenium chloropentacarbonyl and rhenium iodopentacarbonyl in hydrogenation and hydroformylation reactions was studied. The activities of the catalysts in general are comparable with previously characterized rhenium catalysts, particularly in the case of the reduction of benzene and acetic acid.

BRI.01:008

Brigham Young U. [Dept. of Chemistry] Provo, Utah.

AN INVESTIGATION OF RHENIUM AND ITS COMPOUNDS AS CATALYSTS IN ORGANIC REACTIONS, by H. S. Broadbent. Final rept. June 6, 1954-Sept. 6, 1958, 44p. incl. tables, refs. (AFOSR-TR-58-143) (AF 18-500)1164) AD 204733; PB 138719 Unclassified

Studies were made of the catalytic properties of Re and some of its compounds in hydrogenation reactions, and the effect of rhenium trichloride on the course of Grignard reactions. Rhenium heptasulfide was established as the best hydrogenation catalyst among sulfide

BCU.02:002 - BCU.02:005

catalysts. Rhenium disulfide was comparable but not as effective. Studies on the oxides of rhenium, Re_2O_7 , ReO_3 , ReO_2 , $\text{ReO}_2 \cdot 2.5 \text{H}_2\text{O}$, Re_2O_3 , and $\text{ReO} \cdot 2 \text{H}_2\text{O}$ demonstrated that the activity of a substance of a given composition depended on the precise technique used in preparation. New procedures were developed for the preparation of $\text{ReO}_2 \cdot 2.5 \text{H}_2\text{O}$, Re_2O_3 , and $\text{ReO} \cdot 2 \text{H}_2\text{O}$.

Rhenium oxides were not as effective as the standard Pt and Ni catalysts in the hydrogenation of the C-C multiple bond, the ketonic carbonyl group, or the nitro group. The rhenium oxides, particularly rhenium heptoxide in situ, were demonstrated to be the most effective catalysts known in the hydrogenation of carboxylic acids to the corresponding alcohols. Grignard reactions were profoundly altered by the presence of small amounts of transition metal salts. Rhenium trichloride was not significantly effective in this type of reaction in the small amounts used.

BCU.02:002

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

SOME EXTREME VALUE RESULTS FOR INDEFINITE HERMITIAN MATRICES, by M. Marcus, B. N. Moyls, and R. Westwick. Aug. 1957, 20p. (AFOSR-TN-57-357) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)83 and National Research Council of Canada) AD 132430 Unclassified

Also published in Illinois Jour. Math., v. 2: 408-414, Sept. 1958. (Title varies)

The results of an earlier paper (item no. BCU.02:006) have been extended to include extreme values for the r th symmetric functions in the variable a_i , where a_i represents the inner product of Ax_i and x_i , for general values of r up to the dimensionality of the space V_n .

The results are given as an r th symmetric function of terms which are sums of the eigenvalues of the Hermitian matrix A .

BCU.02:003

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

A NOTE ON SYMMETRIC FUNCTIONS OF EIGENVALUES, by M. Marcus and R. Thompson. [1957] [3]p. (AF 18(603)83) Unclassified

Published in Duke Math. Jour., v. 24: 43-45, Mar. 1957.

Wielandt has recently given an extremum characterization of sums of arbitrary eigenvalues of a Hermitian matrix as well as inequalities relating the eigenvalues

of $C = A + B$ with those of A and B . In this paper Wielandt's results are extended to symmetric functions.

BCU.02:004

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

MAXIMUM AND MINIMUM VALUES FOR THE ELEMENTARY SYMMETRIC FUNCTIONS OF HERMITIAN FORMS, by M. Marcus and B. N. Moyls. [1957] [3]p. (AF 18(603)83) Unclassified

Published in Jour. London Math. Soc., v. 32: 375-377, July 1957.

Let A be a Hermitian matrix of order n . For each k between 1 and n , let x_1, x_2, \dots, x_k vary over all sets of k orthonormal vectors in the unitary n -space. If A is nonsingular, it is proved that the linear subspace spanned by a minimizing or maximizing set x_1, \dots, x_k for the function $\Pi = i^k (Ax_1, x_1)$ is invariant under A . If A is positive semi-definite and if $0 \leq \sigma \leq 1$, $1 \leq r \leq k$, then the maximum of the r th elementary symmetric function of $(Ax_1, x_1)^\sigma$ ($1 \leq i \leq k$) is shown to be

$$\binom{k}{r} k^{-\sigma r} \left(\sum_{i=1}^k \lambda_i \right)^{\sigma r},$$

where $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_n$ are the eigenvalues of A . (Math. Rev. abstract)

BCU.02:005

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

CONVEX FUNCTIONS OF QUADRATIC FORMS, by M. Marcus. [1957] [5]p. (AF 18(603)83) Unclassified

Published in Duke Math. Jour., v. 24: 321-326, Sept. 1957.

Let A_1, A_2, \dots, A_k be k pairwise commutative Hermitian matrices of order n , where $n \geq k$. For each $i = 1, 2, \dots, k$, let I_i be the interval formed by all values of $(A_i x, x)$ for $\|x\| = 1$. Let f be a real-valued convex function defined on $I_1 \times I_2 \times \dots \times I_k$. The paper discusses the maximum of $f((A_1 x_1, x_1), \dots, (A_k x_k, x_k))$, when x_1, \dots, x_k vary over all sets of k orthonormal vectors in the unitary n -space. (Math. Rev. abstract)

BCU.02:006

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

SOME EXTREME VALUE RESULTS FOR INDEFINITE HERMITIAN MATRICES, by M. Marcus, B. N. Moyls, and R. Westwick. [1957] [9]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(603)83 and National Research Council of Canada)

Unclassified

Published in Illinois Jour. Math., v. 1: 449-457, Sept. 1957.

Let A be a square, complex indefinite Hermitian matrix of order n which has a set of positive and negative eigenvalues λ_j which can be ordered $\lambda_j \geq \lambda_{j+1}$, and let x_i ($i = 1, \dots, k$) be an orthonormal set of unit vectors in the unitary space V_n . Consider two functions F_1 and F_2 such that F_1 is the product of k of the a_i and F_2 is the second elementary symmetric function of the a_i , where a_i denotes the inner product of Ax_i and x_i . The invariant and extremum properties of the two functions are investigated and it is found that: (1) the set of vectors for which the value of either of the functions assumes a minimum value is such that the set spans a k -dimensional invariant subspace of A . In addition for F_1 the set of vectors which yields a maximum value for F_1 also spans a k -dimensional invariant subspace of A ; (2) the extreme values of F_1 are given as a product of sums of the λ_j ; and (3) the minimum value of F_2 is given as the second elementary symmetric function in the λ 's up to λ_k and the maximum value as a function of the maximum of numbers (a, b) where a and b are given as sums of the λ 's.

BCU.02:007

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

INEQUALITIES FOR SYMMETRIC FUNCTIONS AND HERMITIAN MATRICES, by M. Marcus and L. Lopes. [1957] 8p. (AF 18(603)83) Unclassified

Published in Canad. Jour. Math., v. 9: 305-312, 1957.

For $a_i \geq 0, b_i \geq 0$ ($i = 1 \leq n$) and $1 \leq r \leq n$, the inequality

$$E_r^{1/r}(a_1 + b_1, \dots, a_n + b_n) \geq E_r^{1/r}(a_1, \dots, a_n) +$$

$E_r^{1/r}(b_1, \dots, b_n)$ is proved, where E_r denotes the r th elementary symmetric function. If $E_{r-1}(a_1, \dots, a_n) > 0$, $E_{r-1}(b_1, \dots, b_n) > 0$, then

$$\mathcal{E}_r(a_1 + b_1, \dots, a_n + b_n) \geq \mathcal{E}_r(a_1, \dots, a_n) +$$

$$\mathcal{E}_r(b_1, \dots, b_n), \text{ where}$$

$$\mathcal{E}_r(a_1, \dots, a_n) = \frac{E_r(a_1, \dots, a_n)}{E_{r-1}(a_1, \dots, a_n)}, E_0(a_1, \dots, a_n) = 1.$$

According to the authors, H. Sameison has observed that the first inequality is a consequence of a concavity result of W. Fenchel (C. R. Acad. Sci. Paris, v. 203: 764-766, 1936) on mixed volumes of convex bodies. However, Fenchel's result is not used in the authors' inductive proof. The paper concludes with applications to eigenvalues of the sum of two positive semi-definite Hermitian matrices. In particular, if A, B are two such matrices of order n and if $\{\alpha_i\}, \{\beta_i\}, \{\lambda_i\}$ are the eigenvalues of $A, B, A+B$ respectively, each arranged in increasing order, then

$$E_r^{1/r}(\lambda_1, \lambda_2, \dots, \lambda_k) \geq E_r^{1/r}(\alpha_1, \alpha_2, \dots, \alpha_k) +$$

$$E_r^{1/r}(\beta_1, \dots, \beta_k) \text{ holds for } 1 \leq r \leq k \leq n. \text{ (Math. Rev. abstract)}$$

BCU.02:008

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

ON THE MAXIMUM PRINCIPLE OF KY FAN, by M. Marcus and B. N. Moyls. [1957] [8]p. refs. (AF 18(603)-83) Unclassified

Published in Canad. Jour. Math., v. 9: 313-320, 1957.

The present paper applies the maximum principle of Ky Fan to the case of finite matrices and shows that the following two equations are special cases of a general maximum result for compound operators:

$$(1) \max_{i=1}^k \left| \sum_{j=1}^m (U_1 A_1 \dots U_m A_m x_i, x_i) \right| = \sum_{i=1}^k \sum_{\sigma=1}^m (\prod_{\sigma=1}^m \lambda_{\sigma i})^{1/2};$$

$$(2) \max_{i,j=1, \dots, k} \left| \det \{ (U_1 A_1 \dots U_m A_m x_i, x_j) \} \right|^2 = \prod_{i=1}^k \prod_{\sigma=1}^m \lambda_{\sigma i}.$$

BCU.02:009

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

LINEAR TRANSFORMATIONS ON ALGEBRAS OF MATRICES, by M. Marcus and B. N. Moyls. Aug. 1958, 11p. (AFOSR-TN-58-667) (Bound with its AFOSR-TN-58-668; AD 162200) (AF 18(603)83) AD 162199

Unclassified

Also published in Canad. Jour. Math., v. 11: 61-66, 1959.

BCU.02:010, 011; BCU.03:001, 002

Let M_n denote the algebras of n -square matrices over the complex numbers and let U_n be the unimodular group, H_n the set of Hermitian matrices, and R_k the set of matrices of rank k in M_n . Let $ev(A)$ be the set of n -eigen-values of A , counting multiplicities. The structures are determined for any linear transformation T of M_n into M_n having one or more of the following properties: (1) $T(R_k) \subseteq R_k$ for $k = 1, \dots, n$; (2) $T(U_n) \subseteq U_n$; (3) $\det T(A) = \det A$ for all $A \in H_n$; and (4) $ev(T(A)) = ev(A)$ for all $A \in H_n$. T is not assumed to be a multiplicative homomorphism, but T satisfies $T(\alpha A + \beta B) = \alpha T(A) + \beta T(B)$ for all $A, B \in M_n$ and for all complex numbers α, β . It is shown that if T satisfies property (1) then there exist non-singular matrices U and V such that either $T(A) = UAV$ or $T(A) = UA'V$ for all $A \in M_n$, where A' indicates the transpose of A . If T satisfies properties (2), (3), or (4), then it must in turn satisfy (1). Additional restrictions on U and V are determined in each case.

BCU.02:010

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

EXTREMAL PROPERTIES OF HERMITIAN MATRICES II, by M. Marcus, B. N. Moyls, and R. Westwick. Aug. 1958, 8p. (AFOSR-TN-58-668) (Bound with its AFOSR-TN-58-667; AD 162119) (AF 18(603)83) AD 162200
Unclassified

Also published in Canad. Jour. Math., v. 11: 379-382, 1959.

An extension of the results on the extremal properties of Hermitian matrices of M. Marcus and J. L. McGregor (Canad. Jour. Math., v. 8: 524, 1956) is presented for arbitrary Hermitian matrices. The principal result yields the extreme values of a function which is a sum for all w of the inner product of X_w , which is Grassman exterior product of r unit orthogonal vectors x_i , and $C_r(A)X_w$, which is the exterior product of r terms Ax_i , where A is the matrix in question. The extreme values are given as the r th elementary symmetric function of the eigenvalues of the matrix A , with indices running from 1 to s and $n-k+s+1$ to n , subject to the condition that $0 \leq s \leq k$, where n is the order of the square matrix.

BCU.02:011

[British Columbia U. Dept. of Mathematics, Vancouver (Canada).]

HERMITIAN MANIFOLDS WITH ZERO CURVATURE, by W. M. Boothby. [1958] 5p. [AF 18(603)83]

Unclassified

Published in Mich. Math. Jour., v. 5: 229-233, 1958.

The problem is considered of determining those complex-analytic manifolds with a Hermitian metric whose curvature vanishes everywhere. It is easy to see that the identical vanishing of the curvature implies that there exists in a neighborhood of each point a field of n independent (in fact, orthonormal) parallel analytic vectors, where n is the dimension of the manifold. If the manifold is simply connected, such a field may then be defined over the entire manifold, and the manifold is therefore parallelisable (a complex-analytic manifold of complex dimension n is said to be parallelisable if there exist n analytic vector fields defined over it which are independent at each point). On the other hand, if a complex-analytic manifold is parallelisable, then it has a Hermitian metric with curvature zero. Hence, for a complex-analytic manifold, the existence of such a metric is a somewhat weaker property than parallelisability. H. C. Wang has shown that a compact, complex-analytic, parallelisable manifold has a complex Lie group as its universal covering space. Here this is generalized to the corresponding theorem for the case of vanishing curvature. (Contractor's abstract)

BCU.03:001

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

NOTE ON GENERALIZED WITT ALGEBRAS, by R. Ree. Apr. 1958, 14p. (AFOSR-TN-58-376) (AF 49(638)152) AD 154283
Unclassified

Also published in Canad. Jour. Math., v. 11: 345-352, 1959.

A proof is given that the outer derivation algebra of a generalized Witt algebra is abelian, assuming that K is infinite; K denotes a field of characteristic $p > 0$.

BCU.03:002

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

DIAGONALS OF DOUBLY STOCHASTIC MATRICES, by M. Marcus and R. Ree. Apr. 1958, 11p. (AFOSR-TN-58-377) (AF 49(638)152) AD 154284
Unclassified

Also published in Quart. Jour. Math., v. 10: 296-302, 1959.

A real n -square matrix $S = (s_{ij})$ which is called doubly stochastic if $s_{ij} \geq 0$, $\sum_{k=1}^n s_{ik} = \sum_{k=1}^n s_{kj} = 1$ for all i and j , is studied for the conjecture that the minimum value of the permanent of S as S varies over all doubly stochastic matrices can be uniquely assumed for the matrix all of whose entries are $1/n$. The permanent of S is defined by

$$p(S) = \sum_{\sigma} \prod_{i=1}^n s_{i\sigma(i)}$$
 where σ varies over all $n!$ permutations of the integers $1, \dots, n$. The statement (b) there exists a permutation σ such that $\sum_{i=1}^n s_{i\sigma(i)} \geq 1$ and $s_{i\sigma(i)} > 0$ for $i = 1, \dots, n$, follows as a consequence of the conjecture and is proved together with some corollaries. Best possible uniform lower bounds are obtained on the elements of some diagonals of a doubly stochastic matrix.

Also published in Proc. Amer. Math. Soc., v. 9: 886-892, Dec. 1958.

Let V be an additively written elementary p -group of order p^n , where $n > 1$, and let $\phi(u, v)$, $\psi(u, v)$ be two biadditive functions defined on V and with values in a field K of characteristic p . Let k be a fixed nonzero element in V , and assume that the following two conditions are satisfied: (1) If α, β are nonzero elements in K then $\alpha\phi(u, v) + \beta\psi(u, v) = 0$ for all v implies $u = 0$; (2) $\phi(k, v) = 0$ for all v . If ϕ is identically zero, these two conditions are equivalent to saying that ψ is nondegenerate. Define an algebra L over K with basis $\{e_u | u \in V, u \neq 0, u \neq k\}$ by the multiplication table:

$$e_u e_v = \phi(u, v) e_{u+v} + \psi(u, v) e_{u+v+k} \text{ where } e_0 = e_k = 0.$$

The purpose of this paper is to show that the algebra L is simple if $p > 2$.

BCU.03:005

British Columbia U. [Dept. of Mathematics] Vancouver (Canada).

LIE ELEMENTS AND AN ALGEBRA ASSOCIATED WITH SHUFFLES, by R. Ree. [1958] [11]p. incl. refs. [AF 49(638)152] Unclassified

Published in Ann. Math., v. 68: 210-220, Sept. 1958.

Let R be any associative commutative ring with 1 and \mathcal{U} the free R -module on the basis elements $a(I)$, where $I = (i_1, \dots, i_r)$ runs over all r -tuples ($r \geq 0$) of numbers from 1 to m . The author defines a commutative associative multiplication on \mathcal{U} by using the notion of a shuffle: If I and $J = (j_1, \dots, j_s)$ are two sequences of integers from 1 to m , then any arrangement of $i_1, \dots, i_r, j_1, \dots, j_s$ in a single sequence $K = (k_1, \dots, k_{r+s})$ such that the order of the i 's and of the j 's is preserved is called a shuffle. In this way I and J give rise to $\binom{r+s}{r}$ shuffles, not necessarily distinct. Now the product in \mathcal{U} is defined by $a(I)a(J) = \sum a(K)$, the sum being taken over all shuffles K of I and J . Next let \mathcal{B} be the algebra of all power series in the noncommuting indeterminates X_1, \dots, X_m over R . Each element $F = \sum a(I)X_I$ of \mathcal{B} defines a linear mapping $\phi: \mathcal{U} \rightarrow R$ by $\phi(a(I)) = a(I)$. Assume that R admits division by any positive integer. Then the author shows (Theorem 2) that F is a Lie element if and only if $\phi(a(I)a(J)) = 0$ for all $I, J \neq \emptyset$. From this result Friedrichs' criterion for Lie elements and the Dynkin-Specht-Wever formula are as deduced. With F and ϕ as before, $\log F$ may be defined as a power series, provided that $\phi(F) = 1$. In that case (Theorem 5) $\log F$ is a Lie element if and only if ϕ is a homomorphism from \mathcal{U} to R . The resulting relations on ϕ , viz. $\phi(I)\phi(J) = \sum \phi(K)$ (where K runs over all shuffles of I and J) are called the shuffle relations. Theorem 5 is shown

BCU.03:003

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

ON GENERALIZED CONJUGATE CLASSES IN A FINITE GROUP, by R. Ree. Apr. 1958, 9p. (AFOSR-TN-58-378) (AF 49(638)152) AD 154285

Unclassified

Also published in Illinois Jour. Math., v. 3: 440-444, Sept. 1959.

A proof is given that the number of σ -classes equals the number of σ -invariant classes of conjugate elements in a finite group where G and σ represent a fixed homomorphism of G into itself. A subset S of G is called σ -invariant if $x\sigma$ implies $x^\sigma \in S$. The above theorem is an immediate consequence of the following theorem: (1) the number of σ -classes in G is equal to the number of σ -invariant irreducible ordinary characters of G , and (2) the number of σ -invariant irreducible modular characters (with respect to p where p is an arbitrary prime number) is equal to the number of σ -invariant p -regular classes of conjugate elements in G . In particular, the number of σ -invariant ordinary characters is equal to the number of σ -invariant classes of conjugate elements in G .

BCU.03:004

British Columbia U. Dept. of Mathematics, Vancouver (Canada).

THE SIMPLICITY OF CERTAIN NONASSOCIATIVE ALGEBRAS, by R. Ree. Apr. 1958, 10p. (AFOSR-TN-58-379) (AF 49(638)152) AD 154286 Unclassified

BRO.01:002 - BRO.01:004

to generalize a result of Chen who proved that $\log F$ is a Lie element whenever the coefficients $\alpha(i)$ are given by integration along a path. (Math. Rev. abstract)

BRO.01:002

Brown U. [Dept. of Mathematics] Providence, R. I.

THE CONFORMAL MAPPING OF SIMPLY-CONNECTED RIEMANN SURFACES, II, by M. Heins. May 1957, 7p. (AFOSR-TN-57-191) (In cooperation with Inst. for Advanced Study, Princeton, N. J.) (AF 18(603)70) AD 126486 Unclassified

Also published in Nagoya Math. Jour., v. 12: 139-143, Dec. 1957.

Using the method of subharmonic functions, the author has modified his earlier proof of the Riemann mapping theorem for simply-connected Riemann surfaces (Ann. Math., v. 50: 686-690, 1949; Nagoya Math. Jour., v. 9: 17-20, 1955). His new version does not make use of Radó's theorem on the existence of a countable base for Riemann surfaces. A by-product is a new proof of this theorem. (Math. Rev. abstract)

BRO.01:003

Brown U. [Dept. of Mathematics] Providence, R. I.

ALGEBRAIC STRUCTURE AND CONFORMAL MAPPING, by M. Heins. May 1957, 17p. (AFOSR-TN-57-192) (In cooperation with Inst. for Advanced Study, Princeton, N. J.) (AF 18(603)70) AD 126487 Unclassified

Also published in Trans. Amer. Math. Soc., v. 89: 267-276, Sept. 1958.

Beginning with the theorem of Bers (Bull. Amer. Math. Soc., v. 54: 311-315, 1948) and the theorem (unpublished) of Chevalley and Kakutani, considerable attention has been given to problems of determining conformal properties of non-compact Riemann surfaces (including plane domains) in terms of algebraic properties of rings or fields of meromorphic functions on them. The present article stems from this circle of ideas and is primarily concerned with the determination of conformal properties of a Riemann surface F in terms of the field $M(F)$ of all meromorphic functions on F . Some of the results in this direction are contained in the following theorems of the author. Theorem A: Let ϕ denote an isomorphism of $M(G)$ into $M(F)$ which preserves the complex constants; then

$$\phi = \{(p, q) \mid (p, q) \in F \times G; \phi(g)(p) = g(q), g \in M(G)\}$$

is either empty or else a conformal (not necessarily one-to-one) map of F into G . Theorem B: If G is compact, or if ϕ is continuous, then ϕ is not empty and

hence is a conformal map of F into G . A subfield K of $M(F)$ is said to be separating if, for each pair of points on F , there is a function in K taking different values at these points. Theorem C: If K_1 is an arbitrary subfield of $M(F)$ containing the complex constants as well as non-constant functions, then there exists a conformal map ψ of F onto a Riemann surface G such that $g \rightarrow g \circ \psi$ maps a separating subfield of $M(G)$ onto K_1 .

This representation is unique up to conformal equivalence. Unlike much of the recent work in this area, the present article considers some of the implications of continuity on the algebraic transformations. In particular, it is shown that every continuous "homomorphism" of $M(F)$ into the complex field plus ∞ is obtained by evaluating the functions of $M(F)$ at some point of F . This is the principal tool used in the proof of Theorem B. (Math. Rev. abstract)

BRO.01:004

Brown U. [Dept. of Mathematics] Providence, R. I.

ON CERTAIN MEROMORPHIC FUNCTIONS OF BOUNDED VALENCE, by M. Heins. Nov. 1957, 9p. (AFOSR-TN-57-502) (In cooperation with Inst. of Advanced Study, Princeton, N. J.) (AF 18(603)70) AD 136492 Unclassified

Also published in Rev. Math. Pures Appl., v. 2: 263-267, 1957.

If E is a closed set in the plane with the property that there are no non-constant bounded analytic functions in the complement of E , then for each open set $O \supset E$ every bounded analytic function in $O - E$ can be extended to be an analytic function in all of O . Thus the AB-null sets in the plane are removable so far as the bounded analytic functions are concerned. If one has a Riemann surface of infinite genus, it is natural to ask in what sense is its boundary "removable"? Heins (Ann. Math., v. 55: 296-317, 1952) established the following theorem, which seems to the reviewer to be the prototype of the sort of thing one should expect of "removability": Let F be an open Riemann surface with a compact relative boundary I' and an ideal boundary consisting of just one end and that of harmonic measure zero. Then there is a mapping ψ of F into a finite Riemann surface G such that every bounded analytic function f on F is the composition $g \circ \psi$ of ψ with a bounded analytic function g on G . (It follows from recent results of Wermer's on function algebras that the hypothesis of this theorem can be weakened to approximately the requirement that each bounded analytic function on F assumes its maximum on I' .) In the present paper Heins gives another criterion or a boundary to be removable in the above sense: Given a Riemann surface F , and suppose that there exists a non-constant meromorphic function f_0 of bounded (finite) valence such that

$$\{w \mid v_{f_0}(w) = \max_{f_0} v_{f_0}\} \in O_{AB}, \text{ where } v_{f_0}(w) \text{ denotes the}$$

BRO.01:005; BRO.02:002-004

number of times f_0 assumes the value w on F . Then there is a conformal mapping ϕ of F into a compact Riemann surface G , such that every function f on F of bounded valence is the composition $g \circ \phi$ of ϕ with a rational function g on G . Further, for each function f of bounded valence on F ($w|v_f(w) = \max v_f \in O_{AB}$ is used. The methods of Heins rely heavily on the theory of interior transformations and on the theory of algebraic structure. They will probably play a fruitful role in the further study of the "removability" of the ideal boundary of Riemann surfaces. (Math. Rev. abstract)

BRO.01:005

Brown U. [Dept. of Mathematics] Providence, R. I.

A THEOREM CONCERNING THE EXISTENCE OF DEFORMABLE CONFORMAL MAPS, by M. Heins. [1958] [3]p. [AF 18(603)70] Unclassified

Published in Ann. Math., v. 67: 42-44, Jan. 1958.

A Riemann surface F is said to admit deformable conformal maps into itself if there is a continuous map f from $F \times [0, 1]$ into F such that for each $t \in [0, 1]$ the mapping $f_t: p \rightarrow f(p, t)$ is a (directly) conformal (not necessarily univalent) map of F into itself and $f_0 \neq f_1$.

The author proves that a hyperbolic Riemann surface F admits deformable conformal maps onto itself if and only if F admits non-constant bounded analytic functions. (Math. Rev. abstract)

BRO.02:002

Brown U. Dept. of Physics, Providence, R. I.

ACOUSTIC STREAMING NEAR A BOUNDARY, by W. L. Nyborg. [1958] [11]p. Incl. diagrs. refs. (AFOSR-TN-57-792) (Sponsored jointly by National Institutes of Health and Air Force Office of Scientific Research under AF 18(603)54) AD 148024 Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 30: 329-339, Apr. 1958.

An approximate solution is developed for steady flow induced near a fluid-solid interface by a sound disturbance. The result is valid, subject to stated conditions, for the flow near any portion of a surface in the vicinity of which the irrotational oscillatory velocity distribution u_1 is known. The validity is limited to the case that the ratio of the kinematic viscosity coefficient of the fluid to the angular frequency of the wave disturbance is small compared to the square of the scale of u_1 . Applications of the general result are made to special situations including that of a small source near a rigid plane. It is found that small

compressible bodies, especially resonant gas bubbles, resting on boundaries are likely sites of pronounced microstreaming in a sound field.

BRO.02:003

Brown U. Dept. of Physics, Providence, R. I.

PHYSICAL MECHANISMS FOR IRRADIATION EFFECTS OF SOUND AND ULTRASOUND (Abstract), by W. L. Nyborg, F. S. Brumachwig and others. [1957] [1]p. (Sponsored jointly by National Institutes of Health and Air Force Office of Scientific Research under AF 18-(603)54) Unclassified

Presented at meeting of the Acoust. Soc. Amer., New York, May 23-25, 1957.

Published in Jour. Acoust. Soc. Amer., v. 29: 768, June 1957.

Of the many known ways in which high-amplitude sound can produce changes in material processes and systems, there are only a few for which the basic physics is understood. In this paper a report will be made on research directed toward some aspects of the general problem. Since typical sonic irradiation conditions seem forbiddingly complex, an attempt has been made to define "elementary" situations for study, which are nevertheless close enough to practical ones to permit carryover of results. Particular attention is being given to fields in liquids in the neighborhood of (1) a single vibrating bubble resting on a wall and (2) a vibrating tip brought near a wall. In the former case there is interest in the heat produced by the bubble; also in heat transfer through the wall, as affected by bubble-associated acoustic streaming. In the second case, acoustic streaming motions are seen near the vibrating tip which, e.g., exert steady viscous forces on the neighboring wall, capable of removing surface films. Observations are also made of steady circulation and related events induced in plant cells when a leaf is contacted with a vibrating tip. The present frequency range is mainly from 10 to 100 kc. Important features of the acoustic streaming patterns can be explained on the basis of an approximate theory for boundary layer.

BRO.02:004

Brown U. Dept. of Physics, Providence, R. I.

SOME LOW TEMPERATURE ULTRASONIC ATTENUATION MEASUREMENTS IN METALS, by R. W. Morse and H. V. Bohm. [1957] [4]p. Incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)54] and Research Corporation) Unclassified

Published in Proc. Fifth Internat'l. Conf. on Low Temperature Phys. and Chem., Madison, Wis. (Aug. 26-

BRO.02:005 - BRO.02:008

31, 1957), Univ. of Wisconsin Press, Madison, 1958, p. 509-512.

Further measurements have been made of the attenuation of ultrasonic waves in pure metals in the helium temperature range where absorption by conduction electrons predominates. The pulse method was used whereby an ultrasonic pulse is generated by a quartz crystal sealed to one of two carefully paralleled faces of the specimen, and the attenuation is measured by the rate of decay of the echoes received by the same crystal. Accurate changes of attenuation with either temperature or applied magnetic field were made by comparing relative changes of a given pulse. The sample was suspended in a helium bath, the temperature of which could be reduced to 1.05°K by pumping. A solenoidal magnetic field capable of 11,000 gauss was used for measuring the effect of magnetic field. Measurements for indium, aluminum, zinc, copper, and polycrystalline indium are given.

BRO.02:005

Brown U. Dept. of Physics, Providence, R. I.

MICROSCOPIC EDDYING NEAR A VIBRATING ULTRASONIC TOOL TIP, by F. J. Jackson and W. L. Nyborg. [1958] [2]p. incl. diagrs. (AFOSR-TN-58-991) (AF 18-603)54) Unclassified

Also published in Jour. Appl. Phys., v. 30: 949-950, June 1959.

An experiment has been performed to determine whether sonic effects in liquids result from a unique stirring action associated with microscopic eddies produced near boundaries by sound. The article discusses the apparatus involved. A tapered cone of circular cross section oscillates longitudinally in near-contact with a rigid boundary. Peak-to-peak vibration amplitudes are of the order of 10^{-5} cm. Two distinct pairs of vortices (A, A' near the cone and B, B' near the boundary) appear in the liquid. A, A' appears whenever the cone oscillates and depends on vibration amplitude for shape and speed. B, B' appears only when the distance h between the boundary and the cone tip is small (in this instance, $\sim 400\mu$). The speed of B, B' decreases rapidly when h increases.

BRO.02:006

Brown U. Dept. of Physics, Providence, R. I.

IMBEDDED THERMISTOR FOR BOUNDARY LAYER MEASUREMENTS, by R. K. Gould and W. L. Nyborg. [1958] [2]p. incl. diagr. (AFOSR-TN-58-992) (AF 18-603)54) Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 31: 249-

250, Feb. 1959.

A technique is discussed for studying localized boundary layer heating and microstreaming. A small thermistor is imbedded in a container, its upper face continuous with the surrounding plastic surface. Sound is generated in a liquid of interest by a 10-kc magnetostrictive oscillator. A gas bubble of desired size is placed near or above the imbedded thermistor. The resistance of the thermistor, measured by a dc Wheatstone bridge, is a sensitive indicator of its temperature. Low current operation is suitable for temperature determination in highly localized fields. Operating at higher currents, the thermistor probes localized near-surface flow fields, especially in respect to effectiveness of different parts of these fields in aiding heat transfer from surface points.

BRO.02:007

Brown U. Dept. of Physics, Providence, R. I.

SELF-MAINTAINED TRANSVERSE OSCILLATIONS OF A JET (Abstract), by W. L. Nyborg. [1958] [1]p. (AF 18(603)54) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Washington, D. C., May 7-10, 1958.

Published in Jour. Acoust. Soc. Amer., v. 30: 676, July 1958.

A thin flat (subsonic) jet, temporarily divided by an edge, tends to set itself into transverse oscillation; the accompanying sounds have been called "edge tones." Any of a number of modes or "stages" may be excited, depending on parameters of the system and on its history. When a resonator is present (as in an organ pipe), further complications appear. Although acoustical and hydrodynamical characteristics of the apparently simple jet-edge system have been studied for over a century, a complete theory still does not exist. An adequate theory should account for the frequency characteristics, jet oscillation configurations, and self-maintenance conditions for the different modes, as well as for the generated vortex arrays. In this paper available information on characteristics of jet-edge and jet-edge-resonator systems will be reviewed, and the more recent theoretical approaches discussed.

BRO.02:008

Brown U. Dept. of Physics, Providence, R. I.

EFFECTS OF ACOUSTIC STREAMING ON THE PHOTOGRAPHIC PROCESSES (Abstract), by F. J. Jackson and W. L. Nyborg. [1958] [1]p. (Sponsored jointly by National Institutes of Health and Air Force Office of Scientific Research under AF 18(603)54) Unclassified

BRO.09:001 - BRO.09:004

Presented at meeting of the Acoust. Soc. Amer.,
Washington, D. C., May 7-10, 1958.

Published in Jour. Acoust. Soc. Amer., v. 30: 678,
July 1958.

It has been known for some time that ultrasonic irradiation of a photographic plate immersed in a liquid causes differential darkening of the emulsion. It was observed by some investigators that suppression of cavitation either entirely eliminated or greatly reduced the darkening action. Because of the complex and erratic nature of typical cavitation, it is difficult to determine which of its many aspects may be responsible for the observed darkening. In experiments to be reported here, it is found that small scale acoustic streaming in the vicinity of the emulsion will cause a darkening effect whether cavitation is present or not. Special experimental arrangements are utilized; by use of moderate sonic amplitudes, cavitation is either entirely suppressed or else carefully controlled. Controlled "cavitation" is effected by allowing a single bubble of appropriate size to be present at the emulsion-liquid interface. Photographs of emulsions irradiated under various conditions (frequencies 10-50 kc) will be shown; density distributions will be compared with those which might be expected on the basis of known characteristics of the acoustic streaming.

BRO.09:001

Brown U. Dept. of Physics, Providence, R. I.

THE SUPERCONDUCTING ENERGY GAP FROM
ULTRASONIC ATTENUATION MEASUREMENTS, by
R. W. Morse and H. V. Bohm. [1957] [10]p. incl. diagrs.
[AF 49(638)6] Unclassified

Also published in Phys. Rev., v. 108: 1094-1096,
Nov. 15, 1957.

The ratio σ_s/σ_n of superconducting to normal attenuation was measured as a function of temperature T for several specimens of S_n and I_n , at frequencies (28-56 mc/sec) such that the ultrasonic wavelength was small compared with the electronic mean free path. The variation of σ_s/σ_n with T followed quite closely a form predicted by Bardeen on the basis of the Bardeen-Cooper-Schrieffer theory. It is suggested that such measurements offer a means of finding the variation of energy gap with temperature.

BRO.09:002

Brown U. [Dept. of Physics] Providence, R. I.

MAGNETIC DEPENDENCE OF ULTRASONIC
ATTENUATION IN METALS AT LOW TEMPERATURES
(Abstract), by R. W. Morse, H. V. Bohm, and [J.] D.

Gavenda. [1958] [1]p. [AF 49(638)6] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York,
Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
44-45, Jan. 29, 1958.

At low temperatures the dominant mechanism of ultrasonic attenuation in pure metals is interaction with conduction electrons. This attenuation is strongly affected by a magnetic field. Helium temperature measurements are reported at frequencies from 8 to 100 mc for fields up to 10 000 gauss in both polycrystal and single crystal samples of indium, tin, copper, aluminum, and zinc. The measurements include longitudinal and shear waves for various orientations of H . The effect depends on the parameter kl , where k is the propagation constant of the wave and l is the electron mean-free-path. When $kl < 1$, the attenuation falls monotonically with applied field, varying as H^{-1} when the radius of the electron orbit $r < l$. When $kl > 1$, the attenuation generally goes through a series of maxima and minima before decreasing monotonically. The resonances are found in both poly- and single crystal samples. The observations in copper and indium are consistent qualitatively with resonances occurring for coincidences of the electron orbit diameter and the ultrasonic wavelength. The results in tin are more complicated suggesting the superposition of another effect which, in contrast to the first, causes a large increase in attenuation with increasing magnetic field. This is strongly frequency-dependent and at 50 mc results in an attenuation for large fields twice that at zero field.

BRO.09:003

Brown U. Dept. of Physics, Providence, R. I.

ELECTRON RESONANCES WITH ULTRASONIC WAVES
IN COPPER, by R. W. Morse, H. V. Bohm, and J. D.
Gavenda. [1958] [10]p. incl. diagrs. (AF 49(638)6)
Unclassified

Published in Phys. Rev., v. 109: 1394-1396, Feb. 15,
1958.

This paper reports magnetic field oscillations in copper and shows that the simple picture of spatial resonance of the electrons with the sound field seems valid. From it one can calculate very reasonable values for the electronic parameters of copper.

BRO.09:004

Brown U. [Dept. of Physics] Providence, R. I.

LOW-TEMPERATURE LATTICE CONDUCTIVITY IN
METALS (Abstract), by R. W. Morse. [1958] [1]p.
[AF 49(638)6] Unclassified

BRO.09:005; BRO.10:001, 002

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
203, May 1, 1958.

The lattice thermal conductivity in metals can be comparable with the electronic conductivity with impure metals or alloys, and with superconductors well below the transition temperature. Phonon-electron scattering generally is the mechanism determining the lattice conductivity. Theory has not been too successful in accounting for the observed conductivity because of uncertainty concerning the shear wave interaction with electrons, and because of the unknown effect of superconductivity on the phonon-electron interaction. Here empirical values of the phonon-electron interaction as deduced from measurements of ultrasonic attenuation will be used to calculate the lattice conductivity of tin, indium, and copper. These apply to both longitudinal and shear waves, and in the case of tin and indium, to both the normal and superconducting states. It is shown that one would expect shear waves to contribute significantly. Calculated lattice conductivities agree reasonably well with values reported in the literature for these metals. The comparison with the temperature dependence of the lattice conductivity in the superconducting states is also fairly good.

BRO.09:005

Brown U. [Dept. of Physics] Providence, R. I.

ULTRASONIC ATTENUATION IN SUPERCONDUCTORS:
DEPENDENCE ON ELECTRON FREE PATH (Abstract),
by H. V. Bohm and R. W. Morse. [1958] [1]p. [AF 49-
(638)6] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
225-226, May 1, 1958.

When the electron mean free path (l) is long compared to the ultrasonic wavelength (λ), i.e., $kl = 2\pi l/\lambda > 1$, then the attenuation of longitudinal waves by electrons in superconductors can be related simply to the superconducting energy-gap of the theory of Bardeen, Cooper, and Schrieffer. We report here measurements in superconducting indium which cover the range of both $kl > 1$ and $kl < 1$. Besides the expected kl dependence on the magnitude of the attenuation, the superconducting attenuation seems to decrease more rapidly below the transition temperature (T_c) the smaller the value of kl when $kl < 1$. The frequency dependence, which is square-law for the normal state when $kl < 1$, is not radically altered throughout the superconducting range (it actually becomes slightly stronger than square-law). A comparison will also be made with shear waves when $kl > 1$.

Here the attenuation shows a considerably more rapid decrease with temperature below T_c than for longitudinal waves of either comparable kl or frequency.

BRO.10:001

Brown U. Div. of Applied Mathematics, Providence, R. I.

THE STRUCTURE OF SUPERSONIC FLOW, by R. E.
Meyer. Jan. 1958, 15p. incl. diagr. refs. (AFOSR-TN-
58-52) (AF 49(638)232) AD 148094 Unclassified

Also published in Zeitschr. Angew. Math. Phys., v. 9B:
454-461, Mar. 25, 1958.

Some known facts concerning the structure in the large of steady, 2-dimensional, shock-free supersonic flow are analyzed, and new results and theories are presented. The invariant properties in the large of wave fronts, branch lines, and limit lines in the steady 2-dimensional, irrotational and homentropic flow of perfect gas are discussed. Closely analogous results hold for the one-dimensional unsteady motion of a perfect inviscid gas, and the analysis may be extended to steady, axially symmetrical, supersonic flow and other hyperbolic problems in 2 independent variables. (Contractor's abstract)

BRO.10:002

Brown U. Div. of Applied Mathematics, Providence, R. I.

AN APPROXIMATE BOUNDARY-LAYER THEORY FOR
SEMI-INFINITE CYLINDERS OF ARBITRARY CROSS-
SECTION, by E. Varley. Jan. 1958 [27]p. incl. diagr.
table. (AFOSR-TN-58-53) (AF 49(638)232) AD 148095
Unclassified

Also published in Jour. Fluid Mech., v. 3: 601-614,
Mar. 1958.

An estimate is given of the distribution of skin frictional force per unit length, and of displacement area, on the outside of a semi-infinite cylinder, of arbitrary cross section, moving steadily in a direction parallel to its generators. A Pohlhausen method is employed with a velocity distribution chosen to yield zero viscous retarding force on the boundary layer approximations. (The smallness of the fluid acceleration far from the leading edge has been shown by Batchelor.) Like the Rayleigh methods, this method is expected to yield reasonable results at large distances from the leading edge. However, for a large class of cross sections, which includes all convex cross sections and locally concave cross sections with re-entrant angles greater than $1/2\pi$, the method yields the expected square root growth of the boundary layer at the leading-edge, with a fairly close approximation to the coefficient, from which it is not unreasonable to suppose that the skin frictional force and displacement area are given with

BRO.10:003, 004; BRO.04:013, 014

reasonable accuracy along the whole length of the cylinder. Results for the elliptic cylinder and the finite flat plate are given in closed form, valid for the whole length of the cylinder, and are expected to be in error by at most 20%. In addition, some estimate is given of the effect of corners on skin frictional force and displacement area. (Contractor's abstract)

BRO.10:003

Brown U. Div. of Applied Mathematics, Providence, R. I.

AN EXPERIMENT ON COMPRESSIBLE FLOW PERTURBATIONS, by T. A. d'Ews Thompson and R. E. Meyer. June 1958, 23p. incl. diagrs. (AFOSR-TN-58-447) (AF 49(638)232) AD 158253 Unclassified

Presented at annual meeting of the Amer. Soc. Mech. Engineers, New York, Nov. 30-Dec. 5, 1958.

Also published in Jour. Appl. Mech., v. 26: 114-119, Mar. 1959.

The effect which a slight tilting of liners of a supersonic wind-tunnel nozzle has on the Mach number distribution in the test-rhombus is determined on the basis of the linear perturbation theory (Aeronaut. Quart., v. 7: 71-84, Feb. 1956). Experiments are reported which (1) confirm that the first-order subsonic and transonic perturbations of the flow may be neglected compared with the supersonic perturbations, and (2) indicate that appreciable effects not accounted for by the first-order theory occur when the flow possesses high local pressure gradients.

BRO.10:004

Brown U. Div. of Applied Mathematics, Providence, R. I.

AERODYNAMIC FORCES ON A CYLINDRICAL SHELL IN PANEL FLUTTER, by M. Hoit. Dec. 1958, 12p. incl. diagrs. (AFOSR-TN-58-974) (AF 49(638)232) AD 205598 Unclassified

Presented at Mechanics Div. AFOSR Contractors meeting, Kansas City, Mo., Oct. 23-24, 1958.

The aerodynamic forces resulting from the unsteady distortion of a circular cylinder of finite length, in a uniform supersonic stream, are determined. The problem is very similar to that of finding the steady flow past a quasi cylindrical duct. The forces on the finite cylinder are compared with corresponding forces on an infinite cylinder, which have been used previously in cylindrical panel flutter analysis. In the case of infinite length, circumferential distortion introduces a constant factor into the expression for the surface pressure. On a cylinder of finite length, circumferential distortion causes the surface pressure to be damped in the axial direction. The effect of finite length of cylinder should therefore be to improve panel flutter characteristics. (Contractor's abstract)

der should therefore be to improve panel flutter characteristics. (Contractor's abstract)

BRO.04:013

Brown U. Div. of Engineering, Providence, R. I.

LINEARIZED TRANSONIC FLOW ABOUT SLENDER BODIES OF REVOLUTION AT ZERO INCIDENCE, by P. F. Maeder and H. U. Thommen. July 1957, 1v. Incl. illus. diagrs. refs. (Technical rept. no. WT-25) (AFOSR-TN-57-384) (AF 18(600)664) AD 132459 Unclassified

The non-linear differential equation for transonic perturbation flow is approximated by a linear equation which contains conventional linearized subsonic and supersonic theories as special cases. The solution to the approximate equation for isolated slender bodies of revolution is presented. Some simple choices of the only remaining transonic parameter are discussed and the theory is applied to parabolic bodies and half-bodies of revolution. Drag measurements on parabolic bodies of revolution of different sizes have been carried out using different types of partly open tunnel walls. (Contractor's abstract)

BRO.04:014

Brown U. Div. of Engineering, Providence, R. I.

AN INVESTIGATION OF THE UNSTEADY FLOW PATTERN IN THE WAKE OF CYLINDERS AND SPHERES USING A HOT-WIRE PROBE, by C. Cometta. Oct. 1957, 31p. incl. illus. diagrs. refs. (Technical rept. no. WT-21) (AFOSR-TN-57-760) (AF 18(600)664) AD 136749 Unclassified

Results obtained by hot wire anemometer surveys of wakes behind circular cylinders at subsonic speeds and high Reynolds numbers are presented. The investigation was concerned in particular with the behavior of the Strouhal number at and near the critical Reynolds number. The irregular range above a Reynolds number of 300, in which turbulent velocity fluctuations accompany the periodic formation of vortices, and which was believed not to extend beyond $Re = 10,000$, is shown to exist up to $Re = 1,000,000$. Above a Reynolds number of $Re = 200,000$ and a cylinder diameter to channel width ratio of 0.23 there appeared two simultaneous vortex streets. On the outside of the ordinary vortex street there were observed two layers containing oscillations of lower frequency. The dependence of the Strouhal number on Reynolds number behind three-dimensional bodies, such as spheres, was determined. Periodic formation of vortices could not be observed above a Reynolds number of 40,000. For spheres of diameter greater than about 2 cm there appeared to be a critical Reynolds number of 7400 at which the Strouhal number changed rapidly from one value to a very much different

BRO.04:015 - BRO.04:018

value. This phenomenon could not be satisfactorily explained. It is believed that there exists only one type of vortex formation for spheres, namely a relatively stable arrangement of vortex loops. (Contractor's abstract)

BRO.04:015

Brown U. Div. of Engineering, Providence, R. I.

REVERSE FLOW AND SUPERSONIC INTERFERENCE, by J. H. Clarke. July 1958 [42]p. incl. diagrs. refs. (AFOSR-TN-58-625) (AF 18(600)664) AD 162155
Unclassified

Also published in Jour. Fluid Mech., v. 6: 272-288, Aug. 1959.

A general analytic proof is presented of the invariance of the drag of an arbitrary spatial distribution of horse-shoe vortices and sources under reversal of the undisturbed flow from a volumetric formulation of the momentum theorem of linearized theory. A reverse-flow relation for steady subsonic or supersonic flow was obtained by consideration of the interference drag of 2 such singularity distributions. The relation, a generalization of the Ursell-Ward theorem, may be applied to configurations with bodies whose surfaces are not quasi-cylindrical and whose surface pressures are quadratically related to the perturbation velocity. The relation is used to discuss several interfering 2-body arrangements in supersonic flow. In certain cases, it was shown that the drag and lift may be determined without knowledge of the interference flow field associated with the arbitrarily prescribed body geometry. The simplicity of the results permits the formulation of optimum problems. The invariance of the drag under flow reversal with unchanged geometry is also established. The role of edge forces in the results is discussed.

BRO.04:016

Brown U. Div. of Engineering, Providence, R. I.

THE CONSTANT-CURRENT HOT-WIRE ANEMOMETER IN SUBSONIC COMPRESSIBLE FLOWS, by D. I. Paddison. Aug. 1958, 37p. incl. diagrs. tables. (Technical rept. no. WT-29) (AFOSR-TN-58-713) (AF 18(600)-664) AD 162248; PB 142119
Unclassified

Measurements have been made of the heat-loss from heated tungsten wires of 0.00015 in. and 0.00035 in. diam over a range of Mach numbers from 0 to 1.05 and Reynolds numbers from 1 to 36. The sensitivities of a constant-current hot-wire anemometer to fluctuations in subsonic flows are presented and some aspects of the use of the instrument are discussed. (Contractor's abstract)

BRO.04:017

Brown U. Div. of Engineering, Providence, R. I.

ON TRANSONIC FLOW ABOUT SLENDER THREE-DIMENSIONAL BODIES, by H. U. Thommen. Sept. 1958 [135]p. incl. illus. diagrs. refs. (Technical rept. no. WT-27) (AFOSR-TN-58-714) (AF 17(600)664) AD 162249; PB 142189
Unclassified

The nonlinear differential equation for the perturbation potential of transonic flow about slender three-dimensional bodies is transformed into a nonlinear integral equation by means of multiple Fourier transforms. Two parameters are introduced, and an attempt is made to choose these parameters locally, such that the nonlinear integral equation can be approximated by a linear one. Two different methods of choosing the parameters are investigated, varying one or both parameters. Pressure distributions were measured on a family of three half bodies of revolution with parabolic nose section. The tests were carried out for Mach numbers from 0.50 to 0.90 in steps of one tenth and from 0.95 to 1.05 in steps of 0.025. Additional tests for a Mach number of 1.10 are incomplete due to the power limitations of the auxiliary suction equipment. All tests were performed using two different wall configurations for the top and bottom walls: (a) longitudinally slotted walls, 18.75% open; and (b) perforated walls, 22% open. The agreement of the measurements for the different walls is in general good. Comparison of the experimental results with the theoretical predictions indicates that the method is suited in its present form only for supersonic free stream (two variable parameters) and for Mach numbers below the critical (one variable parameter). For supercritical but subsonic free stream both methods fail in the region, where in the physical space the flow is locally supersonic. (Contractor's abstract)

BRO.04:018

Brown U. Div. of Engineering, Providence, R. I.

TRANSONIC FLOWS THROUGH A STRAIGHT CASCADE OF SLENDER AIRFOILS, by A. D. Wood. Aug. 1958, 163p. incl. diagrs. refs. (Technical rept. no. WT-28) (AFOSR-TN-58-732) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)664 and Office of Naval Research under Nonr-56209) AD 162267; PB 142095
Unclassified

The steady, transonic flow of an isentropic, isenergetic fluid through an arbitrary two-dimensional cascade of slender airfoils is investigated. By application of a double exponential Fourier transform the nonlinear partial differential equation for the perturbation potential is transformed to a nonlinear integral equation which may, if desired, be solved by an iterative procedure. Two methods are investigated with the object of finding a relatively simple first approximation to the solution in which the nonlinear effects are included. The general

BRO.05:010 - BPO.05:013

transonic result so obtained contains the customary linear subsonic and supersonic solutions as special cases. (Contractor's abstract)

the absolute determination of viscosity at intermediate pressures. (Contractor's abstract)

BRO.05:010

Brown U. [Div. of Engineering] Providence, R. I.

VISCOSITY OF GASES, by J. Kestin. [1957] [10]p. incl. diagrs. tables. [AF 18(600)891] Unclassified

Published in Amer. Inst. Phys. Handbook, ed. by D. E. Gray, N. Y., McGraw-Hill, 1957, p. 201-210.

Definitions and equations are presented for the calculation of the viscosity parameters for various gases. The variation of the viscosity with temperature and pressure is discussed. Tables of viscosity are given, such as the absolute viscosity μ of gases in poises, the kinematic viscosity ν of gases in Stokes (cm^2/sec), the viscosity of water and superheated water vapor, and the kinematic viscosity of water and superheated water vapor.

BRO.05:011

Brown U. Div. of Engineering, Providence, R. I.

THE OSCILLATING-DISK VISCOMETER, A COMPARISON BETWEEN THEORY AND EXPERIMENT, by F. C.-Y. Liu. June 1958, 91p. incl. diagrs. tables, refs. (AFOSR-TN-58-409) (AF 18(600)891) Unclassified

A disk oscillating between two fixed plates has been in use for more than one and one half centuries as an instrument for the measurement of viscosity. A review is given here of the existing theories regarding this kind of instrument, including the theories advanced by Kestin and Person, the scheme originated by Newell and the formula given by Aspettia and Newell. The basic assumptions underlying these schemes are emphasized. All three schemes are subjected to experimental verification by means of the measurements performed by Pilarczyk, and by Kestin and Leidenfrost. Results of the experimental investigation are discussed, and the limits of validity of the different formulas are investigated. The accuracy of each scheme for the evaluation of viscosity is also given. The scheme originated by Kestin and Person gives an uncertainty of no more than 0.1% for relative determinations of viscosity on condition that calibration is performed in the way indicated by Kestin and Wang, and is valid over the whole range of pressures investigated experimentally. The scheme due to Newell has an uncertainty of 0.5% in the absolute determination of viscosity but the error is reduced to less than 0.05% for relative measurements. However, the scheme in question is valid for gases at comparatively low pressures only. The scheme proposed by Aspettia and Newell leads to an uncertainty of 1.5% in

BRO.05:012

Brown U. [Div. of Engineering] Providence, R. I.

THE EFFECT OF MODERATE PRESSURES ON THE VISCOSITY OF FIVE GASES, by J. Kestin and W. Leidenfrost. [1958] [18]p. incl. diagrs. tables, refs. (AFOSR-TN-58-435) (AF 18(600)891) AD 158239 Unclassified

Presented at Symposium on Thermophysical Properties, Purdue U., Lafayette, Ind., Feb. 23-26, 1959.

Also published in Thermodynamic and Transport Properties of Gases, Liquids and Solids, ed. by Y. S. Touloukian, N. Y., Amer. Soc. Mech. Engineers; McGraw-Hill, 1959, p. 321-338.

A brief description of a new oscillating-disk viscometer and the experimental results of measurements on He, O_2 , N_2 , CH_4 , and dry air are given. The experiments were conducted at pressures up to 150 atm and at 20°C , and the results are presented in graphical and tabular form as well as in the form of empirical equations. Expressions for the excess viscosity are given to facilitate the extrapolation to other temperatures and pressures. The measurements are relative to previously measured values on air, N_2 and He and are believed to contain an uncertainty of no more than 0.1%.

BRO.05:013

Brown U. [Div. of Engineering] Providence, R. I.

AN ABSOLUTE DETERMINATION OF THE VISCOSITY OF TWELVE GASES OVER A RANGE OF PRESSURES, by J. Kestin and W. Leidenfrost. [1958] [53]p. incl. diagrs. tables, refs. (AFOSR-TN-58-620) (AF 18(600)-891) AD 162149 Unclassified

Also published in Physica, v. 25: 1033-1062, Nov. 1959.

The measurements were based on a new theory of the oscillating-disk viscometer which includes the effect of the finite radius as well as that of its cylindrical circumference. The theory is first compared with very precise measurements obtained in an instrument whose brief description is also given. The experiments verify the theory to within 0.15% when no correction for the paddle effect of the mirror is applied. The latter has been determined empirically with respect to measurements on air and with it, it is permissible to assume that the theory holds exactly when the boundary layer thickness is large enough, as assumed in Newell's theory. The precise lower bound of the boundary layer thickness for which

BRO. 05:014-017; BRO. 06:002

Newell's theory is applicable has been determined experimentally with reference to measurements on nitrogen. The final measurements performed at 20°C for air, argon, carbon dioxide, deuterium, helium, hydrogen, krypton, neon, nitrogen, oxygen, and water vapor, and, in addition, at 20°C for air, argon, nitrogen, oxygen, and xenon are believed to be accurate, on an absolute basis, to 0.05% and precise to 0.01 - 0.07% depending on the gas. A thorough statistical analysis of the present measurements and those due to Michels and Gibson on nitrogen is given. This shows that apart from being subject to a much larger standard deviation, the latter results are statistically identical with the present measurements over the same range of pressures. It is, consequently, believed that the reliability of both sets of data is very high because they have been obtained by entirely different methods. Extensive numerical results and interpolation formulas are given. (Contractor's abstract)

BRO.05:014

Brown U. Div. of Engineering, Providence, R. I.

AN EXPERIMENTAL INVESTIGATION OF THE INTERNAL FRICTION OF THIN PLATINUM ALLOY WIRES AT LOW FREQUENCIES, by J. Kestin and J. R. Moszynski. July 1958, 30p. incl. diagrs. tables. (Technical rept. no. 11; rept. no. AF-891/11) (AFOSR-TN-58-752) (AF 18(600)891) AD 201516; PB 137431
Unclassified

The measurement of viscosity of gases and vapors by the method of small oscillations requires the knowledge of the internal friction of the suspension wire, and of its variation with temperature. Since these data are not available and in order to choose suitable wires for the steam viscosity measurements, an instrument was built for the measurement of internal friction of thin wires at low frequencies and at elevated temperatures. The instrument is described and results are presented of an investigation of a series of wires made available by Sigmund Cohn and Company. It was found that wires made of No. 479 Platinum Alloy (8% Tungsten, 92% Pt), stress relieved and in sizes of 0.002 in. diam or over are most suitable, and their damping characteristics and elastic constants at any temperature in the range up to 400°C can be predicted quite accurately. (Contractor's abstract)

BRO.05:015

Brown U. [Div. of Engineering] Providence, R. I.

CORRECTIONS FOR THE OSCILLATING DISK VISCOMETER. II, by J. Kestin, W. Leidenfrost, and [F.] C.-Y. Liu. [1958] 13p. incl. diagrs. (AFOSR-TN-58-757) (AF 18(600)891) AD 201616
Unclassified

The derivation of a working formula for intermediate

separations is outlined. Verification is given of the hypothesis that the ratio of the real viscous torque to its ideal value which neglects edge effects (the edge-correction factor) is a unique function of the geometrical dimensions of the experimental arrangement expressed in the form of ratios with respect to the boundary layer thickness. (Contractor's abstract, modified)

BRO.05:016

Brown U. [Div. of Engineering] Providence, R. I.

AN INSTRUMENT FOR THE MEASUREMENT OF THE VISCOSITY OF STEAM AND COMPRESSED WATER, by J. Kestin and J. R. Moszynski. [1958] [6]p. incl. diagrs. refs. (AF 18(600)891)
Unclassified

Presented at meeting of the Amer. Soc. Mech. Engineers, New York, Dec. 1-6, 1957.

Published in Trans. Amer. Soc. Mech. Engineers, v. 80: 1009-1014, July 1958.

This paper describes an instrument designed for the measurement of the viscosity of steam and compressed water. The project, undertaken under this contract, aims at exploring the applicability of the method of observing small torsional oscillations of bodies of revolution to the purpose in hand.

BRO.05:017

Brown U. [Div. of Engineering] Providence, R. I.

ON THE CORRELATION OF EXPERIMENTAL VISCOSITY DATA, by J. Kestin and H. E. Wang. [1958] [5]p. incl. diagrs. tables. [AF 18(600)891]
Unclassified

Published in Physica, v. 24: 604-608, July 1958.

The paper gives empirical correlations for low-density viscosity with temperature and viscosity excess with density, for carbon dioxide (measured by Michels, Botzen and Schuurman) and nitrogen (measured by Lazarre and Vodar). It is shown that in carbon dioxide, the correlation breaks down around the critical point, but otherwise includes the whole range of states from liquid to gaseous. In the case of nitrogen, the correlation seems to break down at the higher densities for lower temperatures. Smoothed values for the viscosity of carbon dioxide are given. (Contractor's abstract)

BRO.06:002

Brown U. Div. of Engineering, Providence, R. I.

SLOW OSCILLATION OF A THIN FINITE DISK IN AN INFINITE FLUID, by A. G. Azpeltia and G. F. Newell.

BRO.06:003 - BRO.06:006

Feb. 1957 [49]p. incl. diagrs. (Technical rept. no. 8)
(AFOSR-TN-57-77) (AF 18(600)1548) AD 120420
Unclassified

The small amplitude oscillation of a thin disk of finite radius suspended in an "infinite" fluid is considered with a view toward its use as a viscometer. The fluid motion is analyzed under the assumption that the boundary layer thickness of the fluid is small compared with the thickness of the disk. Formulas are obtained relating the frequency and decrement of oscillation to the density and viscosity of the fluid. (Contractor's abstract)

BRO.06:003

Brown U. Div. of Engineering, Providence, R. I.

THEORY OF OSCILLATION TYPE VISCOMETER. IV. A THICK DISK, by A. G. Azpeitia and G. F. Newell. Sept. 1957, 33p. incl. diagrs. (Technical rept. no. AF-891/9) (AFOSR-TN-57-594) (AF 18(600)1548) AD 136580
Unclassified

Also published in Zeitschr. Angew. Math. Phys., v. 10: 15-34, 1959.

The viscous drag exerted by a fluid on an oscillating disk is determined by methods similar to those used previously (A. G. Azpeitia and G. F. Newell, Theory of Oscillation Type Viscometers III, A Thin Disk, ZAMP). The problem is to find the viscous drag $D(s)$ by evaluating the integral $D(s)$

$$= \frac{\rho \delta^5 s}{I} \int_A \int \xi^2 \frac{\partial w}{\partial \eta} d\sigma, \text{ in which } w \text{ is a solution of the}$$

$$\text{equation } \frac{\partial^2 w}{\partial \xi^2} + \frac{3}{\xi} \frac{\partial w}{\partial \xi} + \frac{\partial^2 w}{\partial \eta^2} = sw \text{ with the boundary}$$

conditions $w = 1$ on the surface A of the disk; x, η are coordinates which measure positions relative to one edge of the disk whereas ξ, η are the cylindrical coordinates measured from the center of the bottom surface of the disk; the radius of the disk is ξ_0 , the thickness is $2\eta_0$, and the boundary layer thickness is δ . The boundary layer thickness is assumed to be small compared with both the thickness and the radius of the disk. An extrapolation of the formulas derived agrees sufficiently well with those for the thin disk which makes it possible to interpolate between the 2 to evaluate the drag for arbitrary-shaped disks provided the boundary layer thickness is small compared with the radius. The method of solution for the fluid flow near the right angle turn can be applied to the solution of other problems such as heat transfer near a right angle turn. (ASTIA abstract)

BRO.06:004

Brown U. Div. of Engineering, Providence, R. I.

THEORY OF OSCILLATION TYPE VISCOMETERS. V. DISK OSCILLATING BETWEEN FIXED PLATES, by G. F. Newell. Oct. 1957, 24p. incl. diagrs. (Rept. no. AF 891/10) (AFOSR-TN-57-621) (AF 18(600)1548) AD 136610
Unclassified

Also published in Zeitschr. Angew. Math. Phys., v. 10: 160-174, 1959.

A theory is presented of a disk oscillating between 2 fixed plates considered as an instrument for absolute measurements of viscosity. The existing theories relating the viscosity to the decrement of oscillation are improved by calculating the effects of the edge. The separation between the plates is assumed to be small compared with both the radius of the disk and the boundary layer thickness. As compared with the infinite fluid case, the only new feature is the additional boundary condition that the fluid velocity must vanish on the plates instead of at infinity. A comparison is made with the experimental data of Kestin and Pilarczyk (Trans. Amer. Soc. Mech. Engineers, v. 76: 987, 1954) for which the theory discussed is estimated to be correct to 0.1%.

BRO.06:005

Brown U. [Div. of Engineering] Providence, R. I.

STUDY OF EDGE EFFECTS IN FLUID FLOW, by G. [F.] Newell. Final rept. Nov. 27, 1957, 1p. (AFOSR-TR-57-98) (AF 18(600)1548) AD 148022
Unclassified

The report consists of a complete list of technical reports and publications submitted under the contract.

BRO.06:006

Brown U. [Div. of Engineering] Providence, R. I.

DIRECT DETERMINATION OF THE VISCOSITY OF GASES AT HIGH PRESSURES AND TEMPERATURES, by J. Kestin. [1957] [24]p. incl. diagrs. tables, refs. (AF 18(600)1548)
Unclassified

Published in Proc. Second Biennial Gas Dynamics Symposium on Transport Properties in Gases, Northwestern U., Evanston, Ill. (Aug. 26-28, 1957), Evanston, Northwestern U. Press, 1958, p. 27-50.

The most important methods are given for the experimental investigation of the viscosity of gases at high pressures and temperatures. The paucity of experimental data at combined high pressures and temperatures is stressed and the need for a considerable effort in this direction is brought into relief. A general criteria is

BRO.06:007; BRO.11:001;
BRO.08:004, 005

established for a successful viscometer for gases at high pressures and temperatures and it is shown that the capillary viscometer offers the best choice at the present time. The three possible alternatives (the oscillating-body, the rotating-cylinder, and the falling-body viscometers) require an intensive period of development before their potential could be accurately assessed. The main difficulties encountered in their use are connected with the complexities of the flow field which they create. In the first, secondary motion causes the scattering of data and inferior reproducibility. In the last, vortex shedding and pressure drag contribute unaccountable terms to the skin friction force. Some consideration is given to the problem of empirical correlation of experimental data. In particular, it is shown that the well-known correlation between density and the residual viscosity $\mu - \mu_0$, i.e., the difference between its value at a given temperature and pressure, and the corresponding value at zero pressure shows signs of breaking down at high densities.

BRO.06:007

Brown U. [Div. of Engineering] Providence, R. I.

THEORY OF OSCILLATION TYPE VISCOMETERS.
III. A THIN DISK, by A. G. Azpeitia and G. F. Newell.
[1958] [22]p. incl. diagrs. (AF 18(600)1548)

Unclassified

Published in Zeitschr. Angew Math. Phys., v. 9A:
97-118, July 25, 1958.

The small amplitude oscillation of a thin disk of finite radius suspended in an 'infinite' fluid is considered with a view toward its use as a viscometer. The fluid motion is analyzed under the assumption that the boundary layer thickness of the fluid is small compared with the radius of the disk but large compared with the thickness of the disk. Formulas are obtained relating the frequency and decrement of oscillation to the density and viscosity of the fluid. (Contractor's abstract)

BRO.11:001

Brown U. Div. of Engineering, Providence, R. I.

HEAT TRANSFER FROM SURFACES OF NON-UNIFORM TEMPERATURE DISTRIBUTION. PART I. LAMINAR TRANSFER FROM ISOTHERMAL HEAT POLES ON A FLAT PLATE, by H. H. Sogin. Sept. 1958, 1v. incl. diagrs. tables, refs. (AFOSR-TN-58-930) (AF 49(638)-46) AD 205095; PB 139919

Unclassified

A purely hydrodynamic boundary layer grows from the leading edge of a flat plate at zero incidence. Downstream is a heated, isothermal surface of finite length-an isothermal heat pole. It is followed by a second isothermal heat pole, the surface between the two being adiabatic. The Rubesin-Klein-Tribus method is used to

calculate rates of heat transfer by forced convection from the two poles. The general results are applicable to poles of any length in either laminar or turbulent flow. Predictions of laminar transfer are based on Eckert's step function. In experimentation, naphthalene cast in trays is used to simulate the isothermal heat poles while the inert material between them simulates the adiabatic wall. The velocities range from about 40 to 90 FPS, and the air temperatures from 72 to 88°F. The boundary layer is shown to be laminar. The theoretical and experimental results are found to be in good agreement, confirming the calculation method and Eckert's step function. The experimentation is extended to an array of several equally spaced poles in tandem. Effects of roughness and spanwise diffusion are noted. (Contractor's abstract)

BRO.08:004

Brown U. Metals Research Lab., Providence, R. I.

THE INFLUENCE OF DEFINED SMALL AMOUNTS OF IMPURITIES ON THE RECRYSTALLIZATION OF ALUMINUM AFTER SMALL DEFORMATION, by J. Gurland and K. Lücke. Dec. 15, 1957 [28]p. incl. illus. diagrs. tables. (AFOSR-TN-57-785) (AF 18(600)1495) AD 148016

Unclassified

The recrystallization behavior of aluminum with additions of less than 0.1% of Cu, Mg, Si, Mn, Ag, Ni and Zn was studied after tensile deformations of 15%. It was found that the effect of impurities upon the recrystallization of aluminum is much smaller after low deformations than after high deformations, although the calculated activation energies are similar in magnitude ($51 - 61 \times 10^3$ cal/mol). It was noted that for some of the alloy additions the recrystallization temperature, after an initial increase, decreases again with increasing amounts of impurities. This behavior could not be related to the properties of the alloy elements or to any existing theory of recrystallization. (Contractor's abstract)

BRO.08:005

Brown U. Metals Research Lab., Providence, R. I.

SUMMARY OF THE INFLUENCE OF DEFINED IMPURITIES ON THE RECRYSTALLIZATION OF ALUMINUM, by J. Gurland and K. Lücke. Final rept. Aug. 1, 1958, 5p. (AFOSR-TR-58-120) (AF 18(600)1495; continued by AF 49(638)75) AD 202352

Unclassified

The influence of small additions (less than 0.14%) of Cu, Mg, Si, Mn, Ag, Ni, Zn and Fe upon the recrystallization of high purity Al (99.998%) was investigated by x-ray diffraction methods. Deformation of 40% and 90% by rolling: The recrystallization was appreciably delayed by the impurities. Fe additions of the order of 1/100 of a percent increased the recrystallization temperature

BRO.12:001 - BRO.12:003

by 210°C and decreased the rate of recrystallization by a factor up to 10^{11} . Cu, Si, and Mg produced corresponding effects of 150°C and 10^7 . The effect of Ag was much smaller. The increase in recrystallization temperature was caused by atoms in solution and was not due to a second phase. Although generally the recrystallization temperature increased with increasing impurity concentrations, the effect due to the first 0.01% was, in most cases, larger than the increase caused by all the further additions. Deformation of 15% in tension: The effect of impurities upon the recrystallization of Al was much smaller after this low deformation than after the high deformation previously discussed. The recrystallization rate was increased by a factor of only 7 at most, although the calculated activation energies remained similar in magnitude (51 to 61×10^3 cal/mol). With Cu, Ni and Mg, the recrystallization temperature initially increased and then decreased with larger amounts of alloying additions. This unexpected behavior was not caused by difference of grain size or of chemical analysis.

BRO.12:001

Brown U. Metals Research Lab., Providence, R. I.

A SURVEY OF THE RECOVERY OF DAMPING AND MODULUS CHANGES FOLLOWING PLASTIC DEFORMATION, by A. Hikata and A. Granato. Jan. 15, 1957 [24]p. incl. diagrs. table, refs. (Rept. no. AF-136/1) (AFOSR-TN-57-54) (AF 18(603)136) AD 115093 Unclassified

Also published in Acta Metallurgica, v. 6: 470-480, July 1958. (Title varies)

Measurements of the changes in attenuation and elastic constants with time following plastic deformation are compared with the results of a theory which assumes these changes are a result of dislocation pinning by deformation-induced point defects. It is found that the measured time law is that predicted by the theory for specimens which have been deformed between about 0.4 and 4%. For smaller and larger deformations, deviations from this time law are obtained. Although measurements so far available permit only a qualitative check of the predictions of the theory with regard to the dependence of the recovery rate on purity and deformation, a check of the temperature dependence is afforded by recovery measurements of Young's modulus for copper. From these an activation energy for the migration of vacancies in copper is determined to be 1.0 ev. A number of experiments needed for checking the theory further are proposed.

BRO.12:002

Brown U. Metals Research Lab., Providence, R. I.

FATIGUE AND ULTRASONIC ATTENUATION, by R. Truell and A. Hikata. [1957] [8]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)136 and Office of Ordnance Research under DA 19-020-505-ord-3882 and DA 19-020-ord-2598) Unclassified

Presented at Second Pacific Area Nat'l. Meeting of the Amer. Soc. for Testing Materials, Los Angeles, Calif., Sept. 17-18, 1956.

Published in Symposium on Nondestructive Testing, Los Angeles, Calif. (Sept. 17-18, 1956), Philadelphia, Amer. Soc. for Testing Materials, 1957, p. 63-70.

A brief survey of the effects observed in the propagation and recovery behavior of ultrasonic waves in materials during stress or fatigue cycling is presented. In all cases studied, the results show that the ultrasonic attenuation increases as a function of the number of cycles of loading and unloading. The loading in the experiments was done in tension and in tension and compression. The form of the attenuation-cycles curve depends among other things on the magnitude of the load and the speed of cycling.

BRO.12:003

Brown U. Metals Research Lab., Providence, R. I.

THEORY OF THE THERMAL BREAKAWAY OF A PINNED DISLOCATION LINE WITH APPLICATION TO DAMPING PHENOMENA, by L. J. Teutonico, A. Granato, and K. Lücke. May 1, 1958 [136]p. incl. diagrs. tables. (AFOSR-TN-58-512) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)136, Office of Ordnance Research under DA 19-020-ord-3650, and Atomic Energy Commission under AT(30-1)1772) AD 158323 Unclassified

An investigation is made of the model of a pinned dislocation line under stress. The model used is that originally given by Koehler and later employed by Granato and Lücke in their theory of mechanical damping due to dislocations. By taking into account thermal fluctuations the probability of the thermal breakaway of such a dislocation line is calculated. The effect of this breakaway on the decrement and apparent modulus change felt by a stress wave traveling through a solid is also considered. The decrement is found to be both hysteretic, since the dislocation is irreversibly broken away from the pinning agents, and relaxational, since the dislocation passes with a temperature-dependent mean frequency from one configuration of minimum energy through a saddle point configuration to another minimum configuration. A comparison is made of this theory with the Granato-Lücke (G.L.) theory and reveals that the present theory

BRO. 12:004-006; BRO. 13:001, 002

includes: (1) temperature effects which reduce to the G.L. theory as the temperature approaches absolute zero, (2) a dependence on the wave frequency, and (3) a decrement dependence on stress which is different from the G.L. theory but which fits the available data as well as the G. L. theory of mechanical damping.

BRO.12:004

Brown U. Metals Research Lab., Providence, R. I.

ULTRASONIC ATTENUATION IN MILD STEEL UNDER DEFORMATION, by R. G. Bayer. Sept. 15, 1958 [40]p. incl. illus. diagrs. refs. (AFOSR-TN-58-913) (AF 18-603)136 AD 204567 Unclassified

The ultrasonic attenuation as a function of strain was studied for mild steel under various conditions of magnetic field and temperature. From these experiments it has been determined that the behavior of the losses in mild steel as a function of strain results from the combination of magnetic domain mechanisms and dislocation mechanisms. A heuristic model using known magnetic domain losses and known dislocation losses is proposed to explain the observed dependence. (Contractor's abstract)

BRO.12:005

Brown U. Metals Research Lab., Providence, R. I.

MEASUREMENTS OF DEFORMATION AND FATIGUE BY ULTRASONIC METHODS, by R. Truell. Final rept. Oct. 1, 1958 [6]p. (AFOSR-TR-58-139) (AF 18(603)-136) AD 204554 Unclassified

The objective of the work undertaken under this contract has been that of studying fatigue effects in metals. Initially the work in this area was concerned with determining how ultrasonic "attenuation-time" or attenuation and velocity recovery with time after deformation depends on deformation and stress cycling. As more was learned about the interaction of dislocations with point defects and how this affected ultrasonic attenuation and velocity, it became apparent that considerably more work had to be done to understand dislocation behavior and recovery to follow fatigue or stress cycling changes in solid materials. A list of publications is presented concerning the work done on the interaction of point defects with dislocations and the resulting influence on attenuation and velocity.

BRO.12:006

Brown U. Metals Research Lab., Providence, R. I.

EVIDENCE FOR DISLOCATION BREAKAWAY IN PURE ALUMINUM, by R. Truell and R. G. Bayer. [1958] [2]p. incl. diagr. (AF 18(603)136; continued by AF 49(638)450) Unclassified

Published in Phys. Rev., v. 110: 1206-1207, June 1, 1958.

Attention is called to the very rapid increase in acoustic attenuation at low strains (especially below 0.02%), and it is pointed out that this effect has been observed only in the high-purity almost single-crystal aluminum sample; it is not observed for example in much less pure commercial aluminum (about 99.8%). It is proposed that this attenuation increase at very low strain is an example of "dislocation breakaway" and that the effect is caused by an increase in dislocation loop length arising when the dislocations free themselves from relatively weak pinning at low strains.

BRO.13:001

Brown U. Metals Research Lab., Providence, R. I.

GROWTH SELECTION DURING RECRYSTALLIZATION OF ALUMINUM SINGLE CRYSTALS, by H. Yoshida, B. [G.] Liebmann, and K. Lücke. Aug. 15, 1957 [7]p. incl. illus. diagrs. (Rept. no. AF-75/1) (AFOSR-TN-57-539) (AF 49(638)75; continuation of AF 18(600)1495) AD 136525 Unclassified

Artificially nucleated crystals were grown in strained aluminum single crystals by cutting them at one end with pliers and then subjecting them to recrystallization heating. Recrystallization always started at the cut end with many fine grains. After further heating most of these fine grains disappeared and only a few large crystals were left. They grew further into the deformed matrix, and one of them finally occupied the full diameter of the wire. Laue and Debye Scherrer X-ray photographs showed that in the early stage of recrystallization the orientation of the many fine grains were distributed at random. The crystal finally obtained usually had an orientation characterized by a $40^\circ [1\bar{1}1]$ rotation relative to the deformed matrix. This indicates that the preferred orientation of the final crystals originates by growth selection. (Contractor's abstract)

BRO.13:002

Brown U. Metals Research Lab., Providence, R. I.

DETERMINATION OF THE ACTIVATION ENERGY OF VACANCY MIGRATION IN COPPER BY ULTRASONIC METHODS, by A. Granato, A. Hikata, and K. Lücke. [1957] [2]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)75] and Office of Ordnance Research) Unclassified

Published in Phys. Rev., v. 108: 1344-1345, Dec. 1, 1957.

The activation energy of migration of deformation induced vacancies in copper has been determined to be 1.0 ev by means of the analysis of literature data on ultrasonic elastic constant measurements. The analysis

BRO. 13:003; BRO. 14:001;
BRO. 15:001, 002

involves the determination of the activation energy of the defect which produces dislocation pinning and the assumption that this defect is a vacancy.

BRO.13:003

Brown U. Metals Research Lab., Providence, R. I.

INVESTIGATIONS ON RECRYSTALLIZATION IN ALUMINUM SINGLE CRYSTALS, by B. [G.] Liebmann and K. Lücke. Final rept. Sept. 1, 1958, 9p. (AFOSR-TR-58-124) (AF 49(638)75, continued by AF 49(638)479) AD 202925 Unclassified

Grain orientations and growth rates were investigated in strained Al single crystals. The crystals were grown from Al wire, cut, and subjected to recrystallization heating. After additional heating, most of the fine grains disappeared, and only one crystal finally occupied the full diameter of the wire. A large majority of the final crystals showed an orientation which was characterized by a 40° rotation around the [111] axis of the deformed matrix. The results indicated that the preferred orientation of the final crystals originates in growth selection. No preferred orientations were obtained when the single crystal wires, containing 0.09% Fe, 0.09% Si, 0.03% Zn, and 99.79% Al, were annealed for 1 hr or longer between 600° and 640°C prior to deformation. Reheating below 500°C produced typical age-hardening effects. When the reannealing time was increased, the yield point of the crystals increased, reached a maximum, and finally decreased. Recrystallization again produced preferred orientations in samples which had been reheated until the maximum yield point was reached or exceeded.

BRO.14:001

Brown U. Metals Research Lab., Providence, R. I.

INFLUENCE OF THERMAL HISTORY ON PREFERRED ORIENTATIONS IN THE RECRYSTALLIZATION OF TECHNICALLY PURE ALUMINUM, by R. E. Green, Jr., B. G. Liebmann, and H. Yoshida. Nov. 15, 1958 [9]p. incl. diagrs. refs. (AFOSR-TN-58-1014) (AF 49(638)-479; continuation of AF 49(638)75) AD 162279; PB 137931 Unclassified

The influence of the state of impurities (dissolved or precipitated) on the generation of preferred orientations in recrystallization of strained aluminum single crystals has been investigated. The crystals contained 99.79% Al, 0.09% Fe, 0.09% Si and 0.03% Zn, only the iron not being well within its solid solubility limit. No preferred orientations were obtained when the crystals were annealed for several hours at 620°C prior to deformation. On reheating at temperatures below 500°C the yield point of the crystals increased, reached a maximum and finally decreased, a typical behavior correlated to the precipitation of a second phase (iron).

Recrystallization produced preferred orientations in samples which were reheated until the maximum yield point was reached or exceeded. This would indicate that iron in supersaturated solid solution prevents the generation of preferred orientations while it has no effect of this kind when precipitated. This effect of the state of impurities explains contradictory results previously obtained by different groups (Graham-Cahn [Jour. Metals 1956, p. 504, 517] and Liebmann-Lücke-Masing [Zeitschr. Metallk., v. 47: 57, 1956]) investigating growth rates and preferred orientations in the recrystallization of aluminum single crystals. A possible mechanism for the prevention of preferred orientations by dissolved iron is discussed (based on growth selection and interaction between grain boundaries and foreign atoms).

BRO.15:001

Brown U. Metcalf Research Lab., Providence, R. I.

ON THE QUANTUM-STATISTICAL THEORY OF TRANSPORT PROCESSES. I. CORRELATION FUNCTION OF FLUXES, by H. Mori. Oct. 1, 1957, 30p. incl. refs. (AFOSR-TN-57-585) (AF 18(603)87) AD 136581; PB 136171 Unclassified

A time-dependent kinetic equation governing the correlation function of the flux $\Psi_{ff}(t)$ is established for dilute gases and is integrated to give the correlation time in terms of the transport cross section. The spectrum of the binary collision operator Λ_{ij} is determined for intermolecular interactions which have spherically symmetric short range forces. For the hard-core molecule assumption Λ_{ij} consists of two discrete values in the classical limit. If F_p satisfies the equation $\Lambda F_p = \lambda_v F_p$, then $\Psi_{ff}(t) \sim \exp(-t\lambda_v)$, where Λ is the master collision operator. Approximate eigenvalues of Λ are obtained corresponding to the viscosity and heat fluxes. A simple relation between the macroscopic transport coefficient and the corresponding relaxation time in momentum space is derived from the fluctuation-dissipation theorem. This relation leads to a new approach to the transport properties of dilute gases, which is different from Enskog-Chapman's method, but yields the same results in the classical limit. An expansion formula for the canonical transformation describing the motion of a dilute gas is obtained and is employed to clarify the postulate of random a priori phases in the momentum representation for spatially uniform gases. This is done by formulating exactly and quantum-mechanically Brout's idea in the classical derivation of the master equation.

BRO.15:002

Brown U. [Metcalf Research Lab.] Providence, R. I.

CORRELATION TIMES OF FLUXES IN THE QUANTUM

BRO. 15:003, 004; BRO. 16:001

THEORY OF TRANSPORT PROCESSES (Abstract), by H. Mori. [1957] [1]p. [AF 18(603)87] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 203, Apr. 25, 1957.

The various kinetic coefficients can be expressed in terms of the correlation function of the corresponding flux F , $\Psi(t) = \langle FF(t) + F(t)F \rangle$. We mainly consider the viscosity coefficient of the quantum gases η , where

$$F = \sum_{i=1}^N p_{ix} p_{iy}. \text{ The change with time of the Heisenberg}$$

operator $F(t)$ can be described by an operator $T(t, t_0) = \exp[(t - t_0)L]$, where $LF = [F, H]/\hbar$. In order to separate the effects due to the molecular interaction from the free motion, define $K(t, t_0) = \exp(-tL_0)T(t, t_0)X \exp(t_0L_0)$, where L_0 is the L operator of the kinetic energy H_0 .

Then, the binary collision approximation leads, in the limit of $N \rightarrow \infty$, to $K(t, 0) = \exp[\sum_{ij} w_{ij}(t)]$, where w_{ij} is related to the scattering matrix for the collision between molecules i and j to give $\langle p | w_{ij} | p \rangle = t_{ij} p | F | p$.

Ω_{ij} is the collision integral operator familiar in the kinetic theory of dilute gases and contains the complete quantum-mechanical scattering cross section.

$\psi_{ij} = p_x p_y$, ($p = p_j - p_i$), is an eigenfunction of Ω_{ij} with the eigenvalue $w_{ij} = -3|p|Q(p)/mv$, where $Q(p)$ is the transport cross section. Thus, if, on the average, the deviation of the w_{ij} is small from their average value as for the classical Maxwell molecule, then the correlation function decays exponentially with time to give $\eta = 4\langle F^2 \rangle / 3nkT \langle 2|p| X Q/m \rangle$. The behavior of η is discussed for some potential functions.

BRO.15:003

Brown U. Metcalf Research Lab., Providence, R. I.

TIME-CORRELATION FUNCTIONS IN THE STATISTICAL MECHANICS OF TRANSPORT PROCESSES, by H. Mori. Aug. 1, 1958 [13]p. incl. refs. (AFOSR-TN-58-1015) (AF 18(603)87) AD 208226 Unclassified

Also published in Phys. Rev., v. 111: 694-706, Aug. 1, 1953.

A kinetic equation governing the time dependence of the correlation function of flux is established for dilute gases and is integrated to yield a relation between the correlation time and the transport cross section. The spectrum of the binary collision operator is determined for spherically symmetric forces between molecules, which, for

the hard-core model, consists of two discrete values in the classical limit. Hence it is shown that the question of validity of approximating the correlation function by an exponential decay depends upon the type of intermolecular force and the temperature of the system. Approximate eigenvalues of the master collision operator are obtained corresponding to the fluxes of viscosity and thermal conduction, and their relations to the macroscopic transport coefficients are derived. These relations lead to a new approach to the transport properties of dilute gases, which is different from Enskog-Chapman's method but yields the same results in the classical limit. An expansion formula for the canonical transformation describing the motion of dilute gases is obtained and is employed to clarify the assumption of random a priori phases in the momentum representation for spatially uniform gases. This is done by formulating the quantum-mechanical equivalent of Brout's idea in the classical derivation of the master equation. (Contractor's abstract)

BRO.15:004

Brown U. [Metcalf Research Lab.] Providence, R. I.

TRANSPORT EQUATION IN QUANTUM GASES, by H. Mori and J. Ross. [1958] [6]p. incl. refs. (AFOSR-TN-58-1064) (AF 18(603)87) AD 222511 Unclassified

Also published in Phys. Rev., v. 109: 1877-1882, Mar. 15, 1958.

A derivation of the quantum-mechanical analog of the Maxwell-Boltzmann equation of transport for gases at low density is presented. The analysis requires: the definition of a time differential which is necessary for the selection of only secular variations in the time dependence of the distribution functions (coarse-graining in time); a binary collision approximation; the connection between the phase-space transformation function, relating the Wigner distribution function at different times, and the transition matrix in the theory of scattering of two particles; and a coarse-graining in configuration space leading to a kinetic equation for spatially nonuniform systems. A consequence of the binary collision approximation is the exclusion of the effects of symmetrization (Bose-Einstein or Fermi-Dirac statistics) resulting in density-dependent terms. (Contractor's abstract)

BRO.16:001

Brown U. Metcalf [Research Lab.] Providence, R. I.

DIELECTRIC RELAXATION IN SOLID HYDROGEN HALIDES, by R. H. Cole and S. Havriliak, Jr. [1957] [8]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49-(638)31] and Office of Ordnance Research) Unclassified

Published in Faraday Soc. Discussions, No. 23: 31-38, 1957.

BRO. 16:002-005; BRO. 17:001

Dielectric constant and loss measurements of solid hydrogen chloride, and hydrogen and deuterium bromide and iodide, are summarized and discussed in relation to order-disorder phase transitions. Electrostatic calculations indicate the importance of dipole interactions for the structures and rates of molecular orientation in the low temperature phases, but specific effects show the significance of other factors as well. In the less ordered temperature phases, the dispersion behavior is characteristically different, but more complete dielectric measurements and structural evidence will be needed for a proper understanding. (Contractor's abstract)

the dielectric-filled section the complex dielectric constant may be readily calculated. Measurements at 1 and 3 kmc with several liquids of diverse dielectric character are in satisfactory agreement with values reported elsewhere. (Contractor's abstract)

BRO.16:004

Brown U. Metcalf [Research Lab.] Providence, R. I.

THE VISCOSITIES OF SOME UNDERCOOLED LIQUID ALKYL HALIDES, by D. J. Denney. [1958] [12]p. incl. table, refs. (AFOSR-TN-58-664) (AF 49(638)31) AD 162195 Unclassified

Also published in Jour. Chem. Phys., v. 30: 159-162, Jan. 1959.

The viscosities of i-butyl bromide, i-amyl bromide, and i-butyl chloride were measured over a temperature range in which η changed from 10^2 poise to about 10^8 poise. The temperature dependence of η is very close to that of the dielectric relaxation time indicating the similarity of the molecular processes involved. This similarity thus appears to apply to 'non-associated' polar liquids as well as to hydrogen bonded liquids. (Contractor's abstract, modified)

BRO.16:005

Brown U. Metcalf [Research Lab.] Providence, R. I.

DIELECTRIC RELAXATION IN SOME TWO-COMPONENT SYSTEMS, by D. J. Denney. [1958] [15]p. incl. diagrs. tables, refs. (AFOSR-TN-58-795) (AF 49(638)-31) AD 202228 Unclassified

Also published in Jour. Chem. Phys., v. 30: 1019-1024, Apr. 1959.

Dielectric relaxation measurements were made on a number of two-component systems involving both associated and non-associated liquids. Several systems involve two polar components while others are composed of a polar solute or solutes in a non-polar solvent. The results are discussed in terms of Schallamach's suggestions concerning the molecular nature of these mixtures and the size of the liquid region involved in the relaxation process. (Contractor's abstract)

BRO.17:001

Brown U. Metcalf Research Lab., Providence, R. I.

PYROLYSIS OF SIMPLE HYDROCARBONS IN SHOCK WAVES, by E. F. Greene, R. L. Taylor, and W. L. Patterson, Jr. May 1958 [7]p. incl. diagrs. tables, refs. (AFOSR-TN-58-15) (AF 49(638)167) AD 148053 Unclassified

BRO.16:002

Brown U. Metcalf [Research Lab.] Providence, R. I.

A COAXIAL DISPLACEMENT DIELECTRIC CELL FOR LIQUIDS USABLE TO 250 Mc/s, by S. E. Lovell and R. H. Cole. [1958] 5p. (AFOSR-TN-58-662) (AF 49-638)31) AD 162193 Unclassified

Also published in Rev. Scient. Instruments, v. 30: 361-362, May 1959.

A cell has been developed for bridge measurements of capacitance and dielectric or conduction loss in liquids at frequencies up to 250 mc/s. The apparatus consists basically of a short length of coaxial line, filled with liquid, with a dielectric plunger which can be moved axially to replace variable amounts of liquid in the annular space between the conductors. The measured changes in capacitance and conductance with plunger displacement can then be used to calculate the dielectric properties of the displaced liquid. Corrections for imperfect plunger fit, lead capacitance, and inductance are small, and procedures for making them are given. Dielectric constants from 3 to 300 and high losses can be measured from -70 to 100°C with 3cc or less of sample.

BRO 16:003

Brown U. [Metcalf Research Lab.] Providence, R. I.

A BRIDGE METHOD FOR MICROWAVE DIELECTRIC MEASUREMENTS, by S. H. Glarum. [1958] [13]p. incl. tables, refs. (AFOSR-TN-58-663) (AF 49(638)31) AD 162194 Unclassified

Also published in Rev. Scient. Instruments, v. 29: 1016-1019, Nov. 1958.

A method for measuring complex dielectric constants of liquids is described. It involves the variation of the length of a short-circuited section of transmission line until its input admittance is solely resistive. A novel microwave bridge indicates when this condition is fulfilled and simultaneously measures the admittance. From a knowledge of this admittance and the length of

BUR.01:001 - BUR.01:004

Also published in Jour. Phys. Chem., v. 62: 238-244, Feb. 1958.

Shock waves have been used to produce rapid, homogeneous heating in simple hydrocarbons (CH_4 , C_2H_6 , C_2H_4 , C_2H_2 , and C_6H_6) in a temperature range of 1600-2500°K. The pyrolysis products were condensed at the temperature of liquid nitrogen and analyzed by infrared and gas chromatographic methods. The results support Porter's acetylene mechanism for hydrocarbon pyrolysis and indicate that diacetylene is likely to be the first intermediate formed in the reaction of acetylene to form solid carbon and hydrogen. (Contractor's abstract)

Brussels U. (Belgium) see Free U. of Brussels (Belgium)

BUR.01:001

Burden Neurological Inst. [Physiological Dept.]
Bristol (Gt. Brit.).

SOME RECENT DEVELOPMENTS IN ELECTRO-ENCEPHALOGRAPHY, by H. W. Shipton. [1957] [5]p. incl. illus. diags. [AF 61(514)1178] Unclassified

Published in Brit. Commun. and Electronics, v. 4: 222-226, Apr. 1957.

Electroencephalography techniques are surveyed from the laboratory, rather than in the clinic, viewpoint. The automatic LF wave analyser is described with recent improvements. Transistor amplifiers, incorporated in machines with more channels than the usual 6 or 8, have been developed and their disadvantages, e.g. liability to drift, sensitivity to temperature change, and high noise level, have been fairly easily overcome. The evolution of the "toposcopic" display system, developed at Burden Neurological Institute for measurement of signal frequency and spatial location rather than amplitude, is reported and includes a description of the most recent innovation, the circular sweep toposcope.

BUR.01:002

Burden Neurological Inst. [Physiological Dept.]
Bristol (Gt. Brit.).

THE BRAIN AS A MACHINE, by W. G. Walker. [1957] [10]p. incl. illus. diags. [AF 61(514)1178] Unclassified

Published in Proc. Royal Soc. Med., v. 50: 799-808, Oct. 1957.

Experiments and their results are reported for the investigation of how brain mechanisms operate during

the course of learning and forgetting in humans. An assumption has been made that the mechanics of brain function are based on processes of statistical selection and reflexion. The particular aspect of these processes discussed is "timing", or coordination in time, of the preservation and classification of a sequence of events. Time and space relations of electrical events in the brain have been measured by a toposcopic method employing a cluster of 22 cathode ray tubes. In this method rhythmic variations in voltage are transformed into changes of brilliance and then projected upon a spiral scanning time-base, the speed of which can be very accurately controlled and adjusted. Since the scale is coiled helically on the tubes, the length of photographic exposure can be prolonged achieving "line-to-line correlation." The extreme regularity and stability of the alpha processes in the subjects studied, and the subtle variations during thinking, strongly suggest that there is available a mechanism for preserving and comparing the sequence of events in time.

BUR.01:003

Burden Neurological Inst. Physiological Dept.,
Bristol (Gt. Brit.).

ANALYTICAL METHODS OF STUDYING CONDITIONED BEHAVIOUR IN HUMAN SUBJECTS, by R. Cooper, H. W. Shipton and others. [1957] [5]p. [AF 61(514)1178] Unclassified

Published in Proc. Fourth Internat'l. EEG Congress, 1957, p. 336-343.

Experiments have been undertaken to study the cerebral and somatic accompaniments of learning by association in a number of human subjects observed in many subjects that during the preparatory phase of alertness there are very slight but characteristic transient changes in alpha frequency of the order of a fraction of a cycle per second, and these changes have a geometrical distribution in each individual.

BUR.01:004

Burden Neurological Inst. Physiological Dept.,
Bristol (Gt. Brit.).

AN IMPROVED ELECTROTOPOSCOPE, by H. W. Shipton. [1957] [1]p. [AF 61(514)1178] Unclassified

Published in EEG Clin. Neurophysiol., v. 9: 182, 1957.

A system has been devised in which spiral scan is used. The diameter of the scan is increased smoothly during the camera exposure so that repetitive signals lie on the same angular bearing but with changing radius. Thus trace-to-trace correlation is substituted for the summation process of earlier systems. It has been shown that this leads to an improvement in signal noise ratio, and alleviates ambiguities which otherwise would arise.

BUR.01:005, 006; BMB.02:005, 006

BUR.01:005

Burden Neurological Inst. Physiological Dept.,
Bristol (Gt. Brit.).

[THE PRESENTATION AND IDENTIFICATION OF THE COMPONENTS OF THE ALPHA RHYTHMS] La présentation et l'identification des composantes des rythmes alpha, by W. G. Walter and J. Shipton. [1957] [8]p. (AF 61(514)1178) Unclassified

Published in EEG Clin. Neurophysiol., Suppl. 6: 177-184, 1957.

"Alpha rhythms show variations of topology, amplitude, frequency and phase with respect to one another and ... to time, so that methods for studying them should envisage a 7-dimensional continuum. No methods yet described approach this ideal, nor is it easy to relate more than a few of these parameters to estimates of mentality or personality." A combination of frequency analysis and toposcopy contains a good proportion of the basic information, but data presented in these coordinates have to be further processed to relate them to changes during an experiment. It has been demonstrated that alpha rhythms are essentially plural and that their differential components are distinguishable by their frequency, phase relations in various regions, domains, and relations to mental changes.

BUR.01:006

Burden Neurological Inst. Physiological Dept.,
Bristol (Gt. Brit.):

SPATIAL AND TEMPORAL IDENTIFICATION OF ALPHA ACTIVITIES IN RELATION TO INDIVIDUAL MENTAL STATES, BY MEANS OF THE 22-CHANNEL HELICAL SCAN TOPOSCOPE, by R. Cooper, H. W. Shipton and others. [1957] [1]p. (AF 61(514)1178) Unclassified

Published in EEG Clin. Neurophysiol., v. 9: 375, 1957.

This method is suitable for studying the fine structure of the characteristic individual response to a variety of stimulus situations. Use of this system with pattern flash stimulation facilitates distinction between spontaneous activity synchronized by specific stimuli and responses evoked by photic stimulation. Experiments are in progress to test hypotheses relating the identity of alpha activities to specific physiological functions.

BMB.02:005

Bureau of Mines, Bartlesville, Okla.

MELTING-POINT PURITY DETERMINATIONS: LIMITATIONS AS EVIDENCED BY CALORIMETRIC STUDIES IN THE MELTING REGION, by J. P.

McCullough and G. Waddington. Jan. 15, 1957 [41]p. incl. diagrs. tables, refs. (Contribution no. 65) (AFOSR-TN-57-1) (Sponsored jointly by Air Force Office of Scientific Research under [CSO-680-57-4] and American Petroleum Inst.) AD 115031 Unclassified

Presented at Internat'l. Symposium on Purity Control by the Thermal Analysis, Amsterdam (Holland), Apr. 24-26, 1957.

Also published in Anal. Chem. Acta, v. 17: 80-96, July 1957.

Typical melting curves, chosen from the results of more than 125 melting-point studies, are presented to illustrate both the reliability and the inherent limitations of the calorimetric method of purity determination. It is shown that this method usually is one of the best means of accurately determining small concentrations of impurity. However, analysis of anomalous melting curves leads to the conclusion that pseudo-equilibrium curves are often obtained as a result of inhomogeneous distribution of purity in the liquid phase or of non-equilibrium distribution of impurity between the solid and liquid phases. Evidence is given to support the contention that solid solutions were formed in as many as half of the samples studied and that, for this reason, impurity values calculated for perhaps 1/3 of the samples are in error by 200% or more. Although these large uncertainties in impurity values usually correspond to less than 0.1% uncertainty in purity values, modified procedures are proposed to minimize such errors. (Contractor's abstract)

BMB.02:006

Bureau of Mines, Bartlesville, Okla.

THE PRESSURE-VOLUME-TEMPERATURE PROPERTIES OF FLUOROBENZENE, by D. R. Douslin, R. T. Moore and others. Aug. 21, 1957 [34]p. incl. diagrs. tables, refs. (Contribution no. 67) (AFOSR-TN-57-512) (CSO-680-57-4) AD 136498 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 2031-2038, May 5, 1958.

Studies of the pressure-volume-temperature (P-V-T) properties of fluorobenzene have led to basic data for gas compressibility, critical constants, vapor pressure and orthobaric liquid and vapor density. These data have been correlated by means of the Beattie-Bridgeman equation of state, the Cox vapor pressure equation and Stockmayer's intermolecular potential energy function for polar gases. A detailed description of the experimental method is given. (Contractor's abstract)

BMB.02:007, 008; BMB.04:001

BMB.02:007

Bureau of Mines, Bartlesville, Okla.

BENZOTRIFLUORIDE: CHEMICAL THERMODYNAMIC PROPERTIES AND INTERNAL ROTATION, by D. W. Scott, D. R. Douslin and others. Aug. 18, 1958, 25p. incl. tables, refs. (Contribution no. 77) (AFOSR-TN-58-747) (CSO-680-57-4) AD 201515; PB 136876 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 1015-1020, Mar. 5, 1959.

Thermodynamic and spectroscopic data were used to show that internal rotation in benzotrifluoride is nearly free. The chemical thermodynamic properties in the vapor state (0 to 1500°K) were calculated by methods of statistical mechanics. Experimental studies provided the following information: Values of heat capacity for the solid (12°K to the triple point), the liquid (triple point to 370°K) and the vapor (363 to 500°K); the triple point temperature, the heat of fusion; thermodynamic functions for the solid and liquid (0 to 370°K); heat of vaporization (334 to 375°K); second virial coefficient (334 to 500°K); and vapor pressure (328 to 412°K). (Contractor's abstract)

BMB.02:008

Bureau of Mines, Bartlesville, Okla.

THERMOCHEMISTRY AND VAPOR PRESSURE OF ALIPHATIC FLUOROCARBONS. A COMPARISON OF THE C-F AND C-H THERMOCHEMICAL BOND ENERGIES, by W. D. Good, D. R. Douslin and others. Nov. 3, 1958 [28]p. incl. diagr. tables, refs. (AFOSR-TN-58-976) (CSO-680-57-4) AD 205856; PB 137848

Unclassified

Also published in Jour. Phys. Chem., v. 63: 1133-1136, July 1959.

The heat of formation of 4 organic F compounds, including 3 completely fluorinated aliphatic compounds, was determined by a rotating-bomb method of combustion

calorimetry. An earlier technique that used sealed, fused-quartz ampoules for containing samples of volatile F compounds was replaced by an improved technique that used sealed bags of a polyester film. For 3 of the compounds vapor pressure measurements were made by an improved method of comparative ebulliometry.

The following values, in kcal/mol⁻¹, are reported for the standard heat of formation, ΔH_f° , of these compounds from graphite and gaseous F and H: m-fluorobenzotrifluoride(g), -184.1; perfluoromethylcyclohexane(g), -769.7; and perfluoro-n-heptane(g), -789.0. These values were used with other existing thermochemical data to obtain a direct comparison of the C-F and C-H thermochemical bond energies in aliphatic compounds. (Contractor's abstract)

BMP.04:001

Bureau of Mines, Pittsburgh, Pa.

EVIDENCE FOR THE WRINKLED CONTINUOUS LAMINAR WAVE CONCEPT OF TURBULENT BURNING, by J. K. Richmond, W. F. Donaldson and others. Oct. 1, 1957 [26]p. incl. illus. diagrs. refs. (Technical rept. no. 1231) (AFOSR-TN-57-676) (CSO-680-57-14) AD 136666 Unclassified

Presented at Twelfth annual meeting of the Amer. Rocket Soc., New York, Dec. 2-6, 1957.

Also published in Jet Propulsion, v. 28: 393-399, June 1958.

Experimental evidence is presented for the existence of a continuous laminar flame within a turbulent flame brush. Evidence also exists that shows this continuous laminar flame to be applicable to much more highly turbulent flames than is commonly supposed. The most persuasive evidence was obtained by photometric measurement of the transient radiation from flames, whereby a definite correlation with a laminar flame was observed.



CIT.02:005

California Inst. of Tech. Antenna Lab., Pasadena.

PROPAGATION OF ELECTROMAGNETIC WAVES
ALONG CORRUGATED LINES, by G. G. Weill. Dec.
15, 1958, 29p. incl. diagrs. (Technical rept. no. 8)
(AFOSR-TN-57-17) (AF 18(600)1113) AD 115049

Unclassified

The propagation of electromagnetic waves along an infinite "corrugated surface" is investigated by means of integral equations and Fourier transform techniques. Results are obtained which take into account the finite distance between the corrugations. In the E case, results are obtained similar to those previously obtained by R. Eurd (Canad. Jour. Phys., v. 32: 721, 1954).

CIT.02:006

California Inst. of Tech. Antenna Lab., Pasadena.

THREE-DIMENSIONAL LATTICES WITH ISOTROPIC
DIELECTRIC PROPERTIES, by Z. A. Kaprielian.
Jan. 28, 1957, 27p. incl. diagrs. (Technical rept. no.
10) (AFOSR-TN-57-115) (AF 18(600)1113) AD 120468

Unclassified

Expressions are derived for the constitutive dielectric parameters of a cubical lattice whose elements consist of a triad of mutually perpendicular polarizable elements. The analysis gives the fundamental relations for the simulation by suitably disposed dipoles, of three-dimensionally isotropic dielectrics with dielectric constants greater than, equal to, and less than unity. Three different approaches have been used. One of these is a complete and rigorous solution which gives the dielectric tensor for the general case of unrestricted spacing to wavelength ratio. This rigorous analysis shows that the Clausius-Mosotti relation often used in predicting the properties of such lattices is a satisfactory approximation only if the spacing is very small with respect to wavelength. Using the general principles developed in this paper, conditions are derived for the realizability of reflectionless media. (Contractor's abstract)

CIT.02:007

California Inst. of Tech. Antenna Lab., Pasadena.

A NEW JUNCTION TRANSISTOR HIGH-FREQUENCY
CIRCUIT, by R. D. Middlebrook. Mar. 1, 1957, 27p.
diagrs. tables, refs. (Technical rept. no. 9) (AFOSR-
TN-57-116) (AF 18(600)1113) AD 120469;
PB 126020

Unclassified

Presented at I.R.E. National Convention, New York,
Mar. 18-21, 1957.

Also published in I.R.E. National Convention Record,
Pt. 2: 120-133, 1957.

A small-signal equivalent circuit for a junction transistor is presented which is applicable to alloy or grown types of p-n-p or n-p-n transistors, and which is valid from dc up to twice the cutoff frequency. The equivalent circuit is in the form of four short-circuit admittances, each of which can be represented by a simple network of lumped elements constant with frequency. The derivation is based on physical principles and takes into account base widening and collector barrier capacitance. Equations for the equivalent circuit element values are given either in terms of physical parameters or in terms of six practical measurements. The four-admittance representation is given both for common-emitter and common-base connections, and a relation between the common-emitter and the common-base cutoff frequencies is derived and experimentally verified. Measurements of the real and imaginary parts of the four admittances as functions of frequency for several transistors show excellent agreement with the values predicted by the equivalent circuit. (Contractor's abstract)

CIT.02:008

California Inst. of Tech. Antenna Lab., Pasadena.

ELECTROMAGNETIC SCATTERING PROPERTIES OF
A RESONANT PLASMA, by H. Shapiro. May 31, 1957
[59]p. incl. illus. diagrs. refs. (Technical rept. no. 11)
(AFOSR-TN-57-300) (AF 18(600)1113) AD 132371

Unclassified

Presented at Conf. on Ion and Plasma Research,
Maryland U., College Park, Sept. 30-Oct. 2, 1958.

A column of ionized mercury vapor is placed in a parallel plate transmission line and the resulting reflection coefficient observed. From the measurement of reflection coefficient as a function of discharge current, plasma resonance is demonstrated. In accordance with the theory applied, but in contrast to the results of other investigators, resonance is found at only one value of discharge current. The discharge current required to produce resonance is measured as a function of frequency. The functional dependence observed is as predicted by theory, but the current is higher than the theoretical value. The discharge current required to produce resonance is measured as a function of gas pressures. The dependence that is found follows that predicted theoretically at high gas pressure, but deviates sharply from the theoretical form at lower gas pressures. (Contractor's abstract)

CIT.02:009 - CIT.02:013

CIT.02:009

California Inst. of Tech. Antenna Lab., Pasadena.

ON THE APPLICATION OF A VARIATIONAL PRINCIPLE TO ANTENNA THEORY, by C. H. Papas. Nov. 7, 1957, 15p. incl. diagrs. refs. (Technical rept. no. 12) (AFOSR-TN-57-655) (AF 18(600)1113) AD 136641

Unclassified

Presented at Congrès International des Circuits et Antennes Hyperfréquences, Conservatoire National des Arts et Métiers, Paris (France), Oct. 25, 1957.

The strong limitations on the applicability of exact methods of analysis to electromagnetic boundary-value problems encouraged the development of approximation techniques. Among the most practical of the techniques was Schwinger's variational method which eliminated the special difficulties in solving the integral, integro-differential or matrix equations associated with linear antennas. Two complementary forms of the principle were used: one was a function of the surface electric fields and the other was a functional of surface magnetic fields. The complementary forms were applied to the calculation of the input impedance of a circular diffraction antenna consisting of a coaxial waveguide fitted with a limitless flange and open to free space. The difference between the two forms was taken as a measure of the quality of the approximation. The starting point of the principle was the integral equation formulation of the boundary-value problem of waveguide discontinuities. (ASTIA abstract)

CIT.02:010

California Inst. of Tech. Antenna Lab., Pasadena.

ELECTROMAGNETIC WAVES ON CORRUGATED LINES: PROPAGATION CONSTANT MEASUREMENTS, by G. G. Weill and H. Kuehl. Dec. 23, 1957, 9p. incl. illus. diagrs. tables. (Technical rept. no. 13) (AFOSR-TN-57-786) (AF 18(600)1113) AD 148017

Unclassified

The accuracy was investigated experimentally of an approximate formula (CIT.02:005) for the constant of propagation derived from an exact integral equation. The formula showed good agreement with the experiment. (ASTIA abstract)

CIT.02:011

California Inst. of Tech. Antenna Lab., Pasadena.

ON THE HIGH-FREQUENCY OSCILLATIONS OF THE ELECTRONIC PLASMA, by C. H. Papas. Jan. 23, 1958, 15p. incl. diagrs. refs. (Technical rept. no. 14) (AFOSR-TN-58-23) (AF 18(603)1113) AD 148062

Unclassified

An analysis is made of the oscillatory behavior of plasma in the case where the collisions of the electrons with the ions and with each other are negligible and the collision term of Boltzmann's equation can be set equal to zero. Vlasov's and Landau's theories are discussed, and the eigenvalue approach to the problem is only mentioned. By taking the Cauchy principle value of an integral, Vlasov develops a dispersion relation which is valid for large values of the ratio of the angular velocity of the wave to the vector wave number. Landau treats the problem as an initial-value problem in order to overcome certain limitations of Vlasov's solution. (ASTIA abstract)

CIT.02:012

California Inst. of Tech. Antenna Lab., Pasadena.

ON THE ATTENUATION OF GUIDED WAVES IN THE LIMIT OF HIGH FREQUENCIES, by C. H. Papas. Mar. 29, 1958, 9p. incl. diagrs. refs. (Technical rept. no. 15) (AFOSR-TN-58-462) (AF 18(600)1113) AD 158269; PB 135615

Unclassified

The conventional formulas for the attenuation of waves due to the wall losses in uniform waveguides are based on the two assumptions that the wall currents are the same as the loss-free currents and that the surface resistance of the highly conductive walls is isotropic. In the limit of high frequencies the former assumption remains valid whereas the latter assumption breaks down. As the frequency is increased the surface resistance becomes anisotropic in the sense that it assumes different values depending on whether the wall current is longitudinal or transverse. New attenuation formulas are derived, which take into account the high-frequency anisotropy of the surface resistance and hence yield accurate results for all frequencies. (Contractor's abstract)

CIT.02:013

California Inst. of Tech. Antenna Lab., Pasadena.

ANISOTROPIC EFFECTS IN GEOMETRICALLY ISOTROPIC LATTICES, by Z. A. Kaprielian. Mar. 31, 1958 [35]p. incl. diagrs. (Technical rept. no. 16) (AFOSR-TN-58-569) (AF 18(600)1113) AD 158388

Unclassified

Also published in Jour. Appl. Phys., v. 29: 1052-1063, July 1958.

An order of anisotropy related to the granularity of a lattice at high frequencies is described and investigated. Three different approaches were used to evaluate the expression for the dielectric parameters of a cubical lattice with isotropic elements: (1) a molecular analogy with a consideration of static dipole interaction; (2) an

CIT.02:014, 015; CIT.13:001-003

analysis based on the summation of scattered time-varying fields in which it is demonstrated that the use of the trapezoidal summation approximation completely removes retardation effects; and (3) an exact solution valid for all values of spacing to wavelength ratio. The exact solution brings to light the type of anisotropy existing in artificial structures which is usually ignored. This is an anisotropic effect which exists even in arrays composed of isotropic elements arranged in structurally isotropic patterns. The isotropy is caused by the granularity of the artificial structure. At higher frequencies, when the interelement spacing becomes appreciable in terms of wavelength, this granularity becomes important. This effect is calculated in terms of the high-frequency anisotropy tensor. This study also has direct application in the design of isotropic materials for the control and direction of microwave energy.

CIT.02:014

California Inst. of Tech. Antenna Lab., Pasadena.

ON SATELLITE TYPE ANTENNAS, by G. G. Weill and C. Yeh. Aug. 30, 1958 [19]p. incl. diagrs. (Technical rept. no. 17) (AFOSR-TN-58-655) (AF 18(600)1113) AD 162186; PB 137903 Unclassified

Using some previous study of the radiation of an antenna over a perfectly conducting sphere, various structures of antennas for space vehicles are discussed theoretically. The currents induced on the sphere are taken into account for the computation of radiation patterns. (Contractor's abstract)

CIT.02:015

California Inst. of Tech. [Antenna Lab., Pasadena].

ON LANDAU DAMPING (Abstract), by C. H. Papas. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274) (AF 18(600)1113) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The question of Landau damping is theoretically investigated and the tacit assumptions which underlie Landau's deductions are placed in evidence.

CIT.13:001

California Inst. of Tech. Dept. of Electrical Engineering, Pasadena.

A VLF ANTENNA FOR GENERATING A HORIZONTALLY POLARIZED RADIATION FIELD, by R. M. Golden, R. S. Macmillan, and W. V. T. Rusch. July 10, 1957, 20p. incl. diagrs. (Technical rept. no. 2) (AFOSR-

TN-57-9) (AF 18(600)1552) AD 115041 Unclassified

The radiation fields were calculated for a half-wave horizontal, linear antenna located at the surface of a plane earth of finite conductivity. Results indicated that a horizontally polarized field is radiated in the mid-plane perpendicular to the antenna and that this field is zero in the plane of the earth. A vertically polarized ground wave is radiated which is maximum in the direction of the axis of the antenna and zero at right angles to the antenna. Ground resistivity measurements were made at a number of locations in central and southern California. A correlation between these measured values and the geology of the terrain indicated that for the high values of ground resistivity, which are necessary for optimum antenna efficiencies, the rock formations must be relatively unfractured and that the amount of annual rainfall and other climatic conditions are of little significance.

CIT.13:002

California Inst. of Tech. Dept. of Electrical Engineering, Pasadena.

A CALCULATION OF THE RADIATION FIELDS OF WHISTLING ATMOSPHERICS, by R. M. Golden, R. S. Macmillan and others. July 25, 1956, 42p. incl. diagrs. tables. (Technical rept. no. 1) (AFOSR-TN-57-10) (AF 18(600)1552) AD 115042; PB 126595

Unclassified

A consideration of the initial lightning discharge radiation fields and the mechanism by which these fields were drawn out into the dispersed whistler fields serves the purpose in allowing the calculation of the amount of input power to the antenna needed to produce a detectable echo. The results of an earlier analysis of the ULF antenna are employed when it is necessary to consider the efficiency and radiation characteristics of the antenna.

CIT.13:003

California Inst. of Tech. Dept. of Electrical Engineering, Pasadena.

DESIGN AND CONSTRUCTION OF EQUIPMENT USED TO OPERATE A COMMERCIAL POWER LINE AS A VERY LOW FREQUENCY ANTENNA, by R. M. Golden, R. V. Langmuir and others. Oct. 1, 1958, 31p. incl. illus. diagrs. (Technical rept. no. 3) (AFOSR-TN-58-908) (AF 18(600)1552) AD 204514 Unclassified

A system which employs a single-phase, medium voltage power line as a VLF transmitting antenna has been described, and the design and construction of the necessary components have been presented. Excluding the safety network, the only equipment necessary to convert the line into an antenna was 4 high-voltage parallel-

CIT. 13:004; CIT. 03:004-006

resonant circuits, 2 low-voltage parallel-resonant circuits, and 4 series resonant circuits. Although most of this equipment is available commercially, it was found necessary to construct several of the above components. A number of possible uses of this antenna system in vertical propagation experiments has been suggested. However, this paper describes only the theory and details of construction of the system as an aid to researchers who may desire to construct a similar system. (Contractor's abstract)

CIT.13:004

California Inst. of Tech. Dept. of Electrical Engineering, Pasadena.

A NEW ANTENNA TO ELIMINATE GROUND WAVE INTERFERENCE IN IONOSPHERIC SOUNDING EXPERIMENTS, by R. S. Macmillan, W. V. T. Rusch, and R. M. Golden. [1958] (AF 18(600)1552) Unclassified

Published in Jour. Atmospheric and Terrestrial Phys., v. 13: 183-186, Dec. 1958.

The radiation fields of a half-wave, horizontal linear antenna, located at the surface of an imperfect earth have been calculated. It is found that: (1) the horizontal polarized field is radiated in the plane normal to the center of the antenna and is maximum in the vertical direction; (2) the vertically polarized ground wave field is radiated along the axis of the antenna. Descriptions are given of three antennas which have been constructed to investigate further the properties of this type of antenna.

CIT.03:004

California Inst. of Tech. [Dynamic Properties Lab.] Pasadena.

THE BASAL SLIP IN ZINC UNDER STATIC AND DYNAMIC LOADING, by T. Vreeland, Jr., D. S. Wood, and D. S. Clark. May 1957 [40]p. incl. illus. diagrs. table, refs. (AFOSR-TN-57-316) (AF 18(600)490) AD 132387 Unclassified

Also published in Jour. Mech. and Phys. of Solids, v. 6: 111-126, 1958.

This paper presents the results of an investigation of static and dynamic shear behavior of two purities of zinc single crystals. All the crystals tested were in the form of cylindrical rods with the [0001] crystallographic direction parallel to the rod axis. The static tests were performed by applying simple transverse shear loading in one of the slip directions to one end of the crystals with the other end of the crystals rigidly clamped. The static shear stress vs stress strain relations are obtained from these tests. The dynamic tests were conducted by suddenly stopping

(within a period of about 25×10^{-6} sec) one end of the crystals which were moving in the slip direction with various velocities. The resulting waves of plastic shear deformation which propagate from the stopped ends of the crystals toward the free ends are analyzed. The analysis is based upon the assumption that elastic strains may be neglected in comparison with the plastic strains. The use of the results of this analysis in conjunction with measurements of the permanent lateral deflections of the crystals resulting from the dynamic tests leads to the determination of dynamic shear stress vs shear strain relations. The results of this study show that the stress required to produce a given permanent basal shear strain in single crystals of zinc is considerably greater under the dynamic conditions employed than under static conditions. This stress decreases with increasing temperature.

CIT.03:005

California Inst. of Tech. Dynamic Properties Lab., Pasadena.

PARTIALLY PINNED TILT BOUNDARIES, by T. Vreeland, Jr., D. S. Wood, and D. S. Clark. Sept. 1957, 22p. incl. diagrs. (Technical note no. 3) (AFOSR-TN-57-624) (AF 18(600)490) AD 136612 Unclassified

Also published in Acta Metallurgica, v. 7: 240-245, Apr. 1959.

Results are presented of a theoretical study of the conditions under which small angle tilt boundaries in a crystal can be moved when subjected to a stress which does not produce general slip. The dislocations in the boundary are assumed to be partially pinned by Cottrell atmospheres, intersecting substructure, or precipitates along the dislocation lines. The results show that partially pinned dislocation boundaries may move at lower stresses than similarly pinned isolated dislocations if the density of pinned segments is sufficiently low. Stress concentrations at pinned segments on a small angle boundary are discussed. A "yield condition" for motion of certain partially pinned boundaries is described in which pinned dislocations are left behind when the boundary is moved. (Contractor's abstract)

CIT.03:006

California Inst. of Tech. Dynamic Properties Lab., Pasadena.

STUDY OF THE YIELD PHENOMENON IN ZINC SINGLE CRYSTALS, by K. R. King. Nov. 1958, 23p. incl. illus. diagrs. (Technical note no. 4) (AFOSR-TN-58-1023) (AF 18(600)490) AD 162288; PB 137812 Unclassified

The report presents the results of an experimental study of the yield point phenomenon in zinc single crystals. Static and rapid loading shear tests on single crystals

CIT.03:007, 008; CIT.04:003, 004

of 99.99 + per cent purity zinc were performed. Cantilever beam type specimens similar to those used by Parker et al were found to be unsuitable for a study of the yield point phenomenon because of the inhomogeneity of stress on the slip planes. A system was devised for the testing of single crystal specimens in compression which produces a uniform shear stress on the slip planes. The system is suitable for rapid load testing as well as static testing. Distinct upper yield points are exhibited by annealed specimens tested in compression. (Contractor's abstract)

CIT.03:007

California Inst. of Tech. Dynamic Properties Lab., Pasadena.

TILT BOUNDARY MOTION PRODUCED BY STATIC AND DYNAMIC SHEAR STRESS IN ZINC CRYSTALS, by T. Vreeland, Jr. Nov. 1958, 45p. Incl. illus. diagrs. refs. (Technical note no. 5) (AFOSR-TN-58-1065) (AF 18(600)490) AD 207225 Unclassified

Also published in Acta Metallurgica, v. 9: 112-116, Feb. 1961.

Results of an experimental study of the motion of small angle tilt boundaries in crystals of zinc are presented. Crystals grown from 99.999+ per cent purity zinc, and zone refined zinc, were subjected to static and dynamic shear loading. The dynamic loading system employs a gas shock tube to achieve shear stress in the test specimen containing a small angle boundary. The time for the application of a shear stress in the dynamic test is of one μ sec. Boundaries in crystals of zone refined zinc move at static stresses of approximately 3 lb/in.², while stresses of approximately 20 lb/in.² do not move boundaries in 99.999+ per cent purity zinc. The stress required to initiate boundary motion in a dynamic test is one to two orders of magnitude greater than the stress required in the static test. The boundary velocity increases with increasing dynamic stress. The drag stress on the boundary is proportional to the boundary velocity. These observations are discussed in terms of the forces which act on dislocations constituting the small angle tilt boundary. (Contractor's abstract)

CIT.03:008

California Inst. of Tech. Dynamic Properties Lab., Pasadena.

STUDIES OF THE DEFORMATION OF SINGLE CRYSTALS OF ZINC UNDER DYNAMIC CONDITIONS, by D. S. Clark and T. Vreeland, Jr. Summary rept. Nov. 1958, 14p. Incl. refs. (AFOSR-TN-58-163) (AF 18(600)490) AD 207598 Unclassified

The report presents a summary of investigations made

during the period 1952 through 1958 in an attempt to secure a better understanding of the mechanisms of deformation in single crystals. Methods of producing single crystals of zinc have been developed. Distinct differences in static and dynamic stress-strain relations have been shown. A method was devised to study the motion of small angle tilt boundaries under conditions of dynamic loading. A beginning was made of the study of yielding in zinc single crystals and the time delay under rapid loading conditions. (Contractor's abstract)

CIT.04:003

California Inst. of Tech. Gates and Crellin Labs., Pasadena.

THE INFLUENCE OF ULTRASONIC WAVES ON SOME CHEMICAL CONVERSIONS OF ORGANIC COMPOUNDS, by D. L. Currell. Final rept. July 31, 1957, 14p. Incl. tables, refs. (AFOSR-TR-57-51) (AF 18(600)385) AD 136437 Unclassified

Investigations were made to determine whether or not ultrasonic ring cleavage could be realized and the evolution of acetylene gas detected in the absence of AgNO_3 . Benzene, PhBr, PhOH, pyridine, pyrrole, and pyrazine were suspended in pure H_2O . During ultrasonic treatment, the volatile products were swept by an inert gas, either N or Ar, into a trap containing ammoniacal cuprous solution. Reddish-purple cuprous acetylide was collected and titrated for acetylene. When the compound contained heterocyclic N, a parallel experiment was conducted in which a KOH solution was substituted for the cuprous reagent. The alkaline solution which trapped the HCN was treated as the ammoniacal extracts of Ag-containing precipitates. After conversion into prussian blue, the cyano group was estimated colorimetrically. The results indicated that the ultrasonic conversion took place in the absence of Ag. The compounds treated yielded more acetylene when AgNO_3 was present. The cyanide yields were, in general, higher in the absence of AgNO_3 .

CIT.04:004

California Inst. of Tech. Gates and Crellin Labs., Pasadena.

ON THE ULTRASONIC CLEAVAGE OF SOME AROMATIC AND HETEROCYCLIC RINGS, by D. L. Currell and L. Zechmeister. [1957] 12p. Incl. tables, refs. (Contribution no. 2229) (AFOSR-TN-57-429) (AF 18(600)385) AD 136418 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 205-208, Jan. 5, 1958.

It has been reported earlier that upon exposure to

CIT.04:005; CIT.05:008, 009; CIT.06:005

ultrasonic waves in the presence of silver nitrate, certain halogen derivatives yielded silver halide precipitates which contained silver acetylide, silver diacetylide and (when pyridine was treated) also silver cyanide. It has now been shown that similar cleavage reactions also can be realized in the absence of silver, with benzene, bromobenzene, phenol, tropolone, pyridine, and pyrrole. Under these conditions free acetylene and/or hydrogen cyanide evolved. In some instances the ultrasonic cleavage was accelerated by the presence of argon. (Contractor's abstract)

CIT.04:005

California Inst. of Tech. Gates and Crellin Labs., Pasadena.

SOME EXPERIMENTS WITH ULTRASONIC WAVES, by L. Zechmeister and E. F. Magoon. [1957] 6p. incl. refs. (AF 18(600)385) Unclassified

Also published in Festschrift Arthur Stoll, Birkhäuser, Basel (Switzerland), 1957, p. 59-63.

It has been found that certain halogen derivatives yield silver halide precipitates when subjected to ultrasonic waves in the presence of silver nitrate. Aromatically bound halogens have been considered to be passive preventing precipitation by silver ions. The action of the ultrasonic waves seems to lead to a collapse of the aromatic ring with the formation of acetylene. Acetylene has been formed from benzene by the use of ultrasonic waves. The direct cleavage of pyridine to form acetylene and hydrogen cyanide has been possible with a 5% yield.

CIT.05:008

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

EXPANSION PROCEDURES AND SIMILARITY LAWS FOR TRANSONIC FLOW, by A. F. Messiter, Jr. Sept. 1957, 104p. incl. refs. (AFOSR-TN-57-626) (AF 18-(600)383) AD 136613; PB 139955 Unclassified

The transonic flow past slender bodies and thin wings is investigated with the use of a general theory of expansion procedures. It is assumed that the solutions for the velocity components possess asymptotic expansions of a very general form, and the differential equations and boundary conditions for the first and higher approximations are obtained by applying appropriate limiting procedures to the full equations. The following cases are treated: (1) bodies of revolution at zero incidence; (2) bodies of nearly circular cross-section, at zero incidence; (3) bodies of revolution at an angle of attack; and (4) thin wings at zero incidence. Certain first-order similarity laws are derived for these prob-

lems, and the order of magnitude of the error is stated in each case.

CIT.05:009

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

A TWO-DIMENSIONAL AIR INTAKE IN A SONIC STREAM, by L. E. Fraenkel. Mar. 1958, 39p. 'incl. diagrs. refs. (AFOSR-TN-58-113) (AF 18(600)3) AD 152021 Unclassified

Also published in Jour. Fluid Mech., v. 4: 629-643, Nov. 1958.

Transonic small-disturbance theory is applied to a simplified model of the flow near the front of a ducted body. The body is assumed to consist simply of two parallel flat plates which extend from the inlet station to infinity downstream. The velocity far upstream is sonic, and the velocity far downstream in the duct, which is assumed to be known, is slightly subsonic. Air is therefore "spilled" around the intake edges. An analytic solution is found for the resulting flow field up to the "limiting Mach wave", and asymptotic solutions are found for the supersonic flow and for the shock wave far from, and near, the intake edges. The pressure distribution along the outside walls is then known at both ends, and its computation is completed by an empirical procedure. Distributions of pressure along the center-line and along the inside and outside walls are shown. These results may be used to compute the drag of sharp-edged intakes with a very small frontal area. (Contractor's abstract)

CIT.06:005

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

FLUTTER OF CURVED PLATES WITH EDGE COMPRESSION IN SUPERSONIC FLOW, by Y. C. Fung. Mar. 1957 [32]p. incl. diagrs. table, refs. (Rept. no. 5; Galcit rept. no. 86) (AFOSR-TN-57-187) (AF 18(600)1142) AD 126482 Unclassified

Presented at Fifth Midwestern Conference on Fluid Mechanics, Ann Arbor, Mich., Apr. 1-2, 1957.

In order to explain a significant quantitative discrepancy between previous theory and experiments on the large amplitude flutter of buckled plates in a supersonic flow, the effects of the initial curvature and of a static pressure differential across the plate are calculated. It is found that the order of magnitude of the initial deviation from flatness required to account for the discrepancy is quite reasonable, so that the explanation may very well lie in that direction. The critical flutter condition of a buckled plate is sensitive to the mean compressive load

CIT. 06:006; CIT. 07:033, 034

(the so-called "membrane" stress) in the plate. If the plate is not perfectly flat, lateral deflection will occur under edge compression, and for any specific amplitude of deflection the compressive load is less than the critical buckling load of a perfectly flat plate. This reduction of the compressive load is beneficial to the prevention of panel flutter. Hence it is found that, within certain limits, an increase in the initial deviation from flatness raises the critical value of the parameter Q , which is proportional to the dynamic pressure of flow, or the square of the "reduced velocity" at flutter. The static pressure differential across the plate, p , has very little effect on the critical reduced velocity when p is small, but becomes very effective in preventing flutter when p is sufficiently large. The trend of theoretical dependence of the critical reduced velocity on the amplitude of the buckle agrees with that of the experiments in the "large amplitude" flutter range. However, the "small amplitude" flutter that occurred in the experiments when the amplitude of the buckle was very small remains unexplained. Although it cannot be claimed that the analysis brings the theory and experiment into agreement, since the initial warping of the test specimens was unknown and the numerical calculations are severely simplified; the importance of the initial warping is well borne out by such a comparison. (Contractor's abstract)

CIT.06:006

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

ON PANEL FLUTTER, by Y. C. Fung. June 1957, 77p. incl. illus. diagrs. tables, refs. (Rept. no. 6; GALTIT rept. no. 66) (AFOSR-TR-57-49) (AF 13(600)1142) AD 132381 Unclassified

Presented at National summer meeting of the Inst. of Aeronaut. Sciences, Los Angeles, Cal.f., June 17-20, 1957.

Also published in Jour. Aeronaut. Sciences, v. 25: 145-160, Mar. 1958.

Theory and experiments of the "large amplitude" flutter of a buckled plate are discussed. It is shown that an increase in the initial deviation from flatness raises the critical value of the "reduced velocity". The static pressure differential across the plate, p , has very little effect on the critical reduced velocity if p is small, but becomes very effective in preventing flutter when p is sufficiently large. Exploratory experiments show that the panel flutter in a transonic and low supersonic flow is essentially a single-degree-of-freedom one, (i.e., points on the plate oscillate practically in phase). For a plate of given thickness in a flow of given stagnation pressure, flutter first occurs at a critical Mach number, and then may disappear at a higher Mach number; the region of Mach number in which flutter occurs decreases with increasing plate thickness. No detailed experiments

can be quoted for the flutter of unbuckled panels that is supposedly linear in character, however a 'large theoretical literature exists. One center of interest is concerned with a controversy on the applicability of Galerkin's method to panel flutter. To study this problem the flutter condition was formulated as an integral equation and solved by numerical methods, thus avoiding the constraint of assumed modes. For a plate (with finite bending rigidity) the results confirm those given by Galerkin's method. In order to assess the importance of panel flutter in supersonic aircraft design, the limiting amplitude of flutter is calculated. (Contractor's abstract)

CIT.07:033

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

PLANE COUETTE FLOW AT LOW MACH NUMBER ACCORDING TO THE KINETIC THEORY OF GASES, by H.-T. Yang and L. Lees. Feb. 1, 1957, 37p. incl. illus. tables. (Memorandum no. 36) [Sponsored jointly by Air Force Office of Scientific Research and Army Ordnance under DA-04-495-ord-19] AD 126308 Unclassified

The 13-moment approximation developed by H. Grad for solving the Maxwell-Boltzmann equation is applied to the problem of the relative shearing motion between 2 infinite, parallel flat plates (plane Couette flow). In order to bring out the molecular effects as directly as possible, the problem is linearized by requiring that the Mach number is small compared with unity, and that the temperature difference between the 2 plates is small compared with the ambient temperature. According to the linearized Grad equations the shear stress in this case is given by the usual Navier-Stokes relation for all values of the parameter Re/M [where Re = Reynolds number and M = Mach number], in agreement with R. A. Millikan's postulate. Also, the linearized boundary conditions for this problem are identical with the Maxwell slip relations utilized by Millikan, so that the same expressions for slip velocity and drag coefficient are obtained. An examination of the drag obtained by Kuhlthian, Chiang, and Bowyer and Talbot in their rotating cylinder experiments at low densities shows that the variation of $1/C_D M$ [where C_D = drag coefficient] with Re/M is predicted reasonably well by this theory over a range of Mach numbers of 0.15 to 1.40, in spite of the fact that the theory is supposed to hold only for low Mach numbers. (Contractor's abstract)

CIT.07:034

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

THE EFFECT OF A SIMPLE THROAT DISTORTION ON THE FLOW IN A HYPERSONIC WIND-TUNNEL

CIT.07:035 - CIT 07:037

NOZZLE, by R. E. Oliver and R. E. Cummings. [1957] [2]p. incl. diagr. (Sponsored jointly by Office of Ordnance Research and [Air Force Office of Scientific Research] under DA-04-495-ord-19) Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 466-467, June 1957.

An experimental investigation was conducted in the Gaicit $2\frac{1}{2} \times 3$ in. supersonic wind tunnel to determine the effect of a known distortion of the throat section of a hypersonic nozzle on the flow in the region downstream from the throat. The flow in a nozzle with a rectangular throat section was compared with the flow in the same nozzle with the throat region distorted to produce a throat height which varied linearly across the throat section. The flow was investigated by means of pitot pressure surveys in the horizontal plane of symmetry of the undistorted nozzle. The magnitude of the effect produced by this throat distortion was observed to be approximately that predicted by one-dimensional isentropic flow relations. However, the sign of the effect was reversed in about the distance required for a curved Mach line starting at the throat to cross the channel. Mach numbers were determined from isentropic flow relations. The resulting constant Mach number contours in the horizontal plane of symmetry of the undistorted nozzle are shown. Also shown are the approximate characteristics in this plane. The one-dimensional Δ 's presented are the distortions of the constant Mach number contours as predicted by one-dimensional isentropic flow relations. There was no apparent decay of the distortion effect within the region of this investigation.

CIT.07:035

California Inst. of Tech. [Guggenheim Aeronautical Lab.] Pasadena.

NORMAL-FORCE CHARACTERISTICS OF DELTA WINGS AT SUPERSONIC SPEEDS, by S. Lampert. [1957] [9]p. incl. illus. diagrs. (Sponsored jointly by [Air Force Office of Scientific Research] and Army Ordnance under DA-04-495-ord-19) Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 667-674, 682, Sept. 1957.

Some of the more important results of a series of wind-tunnel investigations conducted at the Jet Propulsion Lab. to determine the aerodynamic-force characteristics of delta wings are presented. A family of five delta wings was designed to cover the range of slope ratios, leading-edge slope to Mach wave slope, from 0.15 to 4.1. Lift or normal-force characteristics for these wings were systematically studied as a function of Reynolds number and Mach number. The results of these investigations are presented as normal-force coefficients per radian for the Mach number range 1.33 to 4.55. These measurements are compared with the linear theory both

as a function of Mach number and slope ratio. It was found that the experimental measurements were in good agreement with and exhibited the trend of the theory in the range of slope ratios 0.15 to 0.70; whereas notable departures from the theory were observed for slope ratios greater than 0.70. For a given wing the systematic variation of the wing profile indicated that there existed a much greater dependence of the lift on profile or edge configuration than on Reynolds number for slope ratios greater than 0.70. (Contractor's abstract)

CIT.07:036

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

THE EFFECTS OF BLUNT LEADING EDGES ON DELTA WINGS AT MACH 5.8, by K. F. Nicholson. June 10, 1958, 34p. illus. diagrs. refs. (Memorandum no. 45) (Sponsored jointly by [Air Force Office of Scientific Research] and Army Ordnance under DA-04-495-ord-19) Unclassified

Also published in Jour. Aero/Space Sciences, v. 25: 786-787, Dec. 1958.

Pressure distributions were measured on a series of four delta wings with subsonic and supersonic leading edges, both sharp and blunt. The blunt leading edge radius was about 0.5 per cent of root chord. Schlieren studies were also made to determine top and side view shock locations. The tests were conducted at a nominal Mach number of 5.8, and at Reynolds numbers between 0.335×10^6 and 0.901×10^6 based on root chord. Angular settings covered a range $-0.2 \leq w/V \leq 0.5$ in pitch at zero yaw (about $-11.5^\circ \leq \alpha \leq 30^\circ$), and a range of $v/V = \pm 0.125$ (about $\pm 7.2^\circ$) at a fixed angle of pitch of 11.5° . The effects of bluntness were found to be small. Also, the pressures produced by shock wave interactions with the boundary layer, and the inviscid pressures generated by the blunt leading edges, were found to be small compared with the inviscid pressures producing lift on the basic wing. Spanwise pressure distributions show no similarity to those obtained by linearized theory. Centerline lower surface pressure in pitch at zero yaw is bracketed between the Newtonian value $\Delta P/q = 2(w/V)^2$ and the two-dimensional exact value. (Contractor's abstract)

CIT.07:037

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

AN EXPERIMENTAL INVESTIGATION OF THE STABILITY OF THE HYPERSONIC LAMINAR BOUNDARY LAYER, by A. Demetriades. [1958] [2]p. incl. illus. diagrs. (Sponsored jointly by Office of Ordnance Research and [Air Force Office of Scientific Research] under DA -04-495-ord-19) Unclassified

CIT. 08:009, 010; CIT. 09:007, 008

Published in Jour. Aero/Space Sciences, v. 25: 599-600, Sept. 1958.

The shape of the instability region at $M = 5.8$ is generally preserved in comparison with the stability diagram at lower Mach numbers, although the area it encloses seems to be much smaller. Both neutral branches are displaced to considerably lower frequencies (larger wavelengths) than the Schubauer-Skramstad neutral branches, and to higher Reynolds numbers than the corresponding Laufer-Vrebalovich data at $M = 2.16$. The amplification rates observed were generally small; for example, the total amplification across the instability region is of the order of 1.4 at a nondimensional frequency of 5×10^{-5} .

CIT.08:009

California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

UNSTEADY FLOWS IN AXIAL TURBOMACHINES, by W. D. Rannie and F. E. Marble. [1957] 21p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)178 and Office of Naval Research under Nonr-22023) Unclassified

Of the various unsteady flows that occur in axial turbomachines certain asymmetric disturbances, of wave length large in comparison with blade spacing, have become understood to a certain extent. These disturbances divide themselves into two categories: self-induced oscillations and forced disturbances. A special type of propagating stall appears as a self-induced disturbance; an asymmetric velocity profile introduced at the compressor inlet constitutes a forced disturbance. Both phenomena have been treated from a unified theoretical point of view in which the asymmetric disturbances are linearized and the blade characteristics are assumed quasi-steady. Experimental results are in essential agreement with this theory wherever the limitations of the theory are satisfied. For the self-induced disturbances and the more interesting examples of the forced disturbances, the dominant blade characteristic is the dependence of total pressure loss, rather than the turning angle, upon the local blade inlet angle. (Contractor's abstract)

CIT.08:010

California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

PERFORMANCE OF AXIAL COMPRESSORS WITH ASYMMETRIC INLET FLOWS, by R. Katz. Final rept. June 1958, 150p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-39) (AF 18(600)178) AD 162112; PB 144039 Unclassified

Over-all performance measurements and circumferen-

tial surveys of total pressures, velocities, and flow angles were obtained in an axial compressor in which inlet disturbances covered about 25% of the inlet annulus area. Three configurations were tested to find the principal effects in a single rotor, a complete stage, and a multi-stage machine. A total pressure disturbance at the inlet of a compressor stage was considerably reduced in magnitude and distorted from its original form downstream of the stage; the circumferential extent of the total pressure disturbance was decreased downstream of the stage. The angle perturbations were a maximum at the plane of a blade row and decreased exponentially upstream and downstream. Large perturbed flow angles downstream of a rotor blade row could cause stalling and flow separation in the following stator blade row when the axial spacing was small. In a multi-stage compressor an inlet disturbance was rapidly reduced through the stages. Ideally, the average total pressure was unaffected by an inlet disturbance; losses which occurred in the rotor and stator blade rows caused the average total pressure to be reduced. At the lower flow rates, the losses were the greatest. A linearized theory was developed which correctly describes the flow process. The additional blade forces were largest when the losses and the leaving angle deviations were neglected. A safe estimate of blade forces may be made with only a knowledge of the disturbance and the mean flow characteristics of the compressor.

CIT.09:007

California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

EMISSIVITY ESTIMATES FOR HEATED NO, by A. Thomson. Nov. 1957, 1v. incl. diagrs. tables. (Technical rept. no. 6) (AFOSR-TN-57-782) (AF 18(603)2) AD 148388 Unclassified

The emissivity of the β and γ systems of NO has been calculated between 4000°K and 6000°K for a range of optical densities. Both the positions and intensities of the bands were assumed to be distributed statistically. An approximately uniform average value for the square of the vibrational matrix elements was assigned to all contributing transitions. The emissivity was calculated at low pressure (pure Doppler broadening) and at high pressure (no rotational fine structure). It is found that, for the specified temperature range, the error induced by neglecting the rotational fine structure is less than 40%. The results obtained do not differ by more than about 50% from those described by Kivel, Mayer and Bethe although the present analytical procedure is quite different. (Contractor's abstract)

CIT.09:008

California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

THE DETERMINATION OF ABSOLUTE INTENSITIES

CIT.09:009, 010; CIT.14:001, 002

AND f-NUMBERS FROM SHOCK TUBE STUDIES, by S. S. Penner. Dec. 1957, 42p. incl. refs. (Technical rept. no. 5) (AFOSR-TN-58-11) (AF 18(603)2) AD 142722 Unclassified

Also published in NATO AGARDographs, no. 41: 161-182, 1961.

A discussion is presented of the experimental and computational procedures in determining radiant energy transfer. The basic physical laws are outlined which refer to equilibrium radiation from heated gases. A critical evaluation is made of experimental procedures for absolute intensity measurements which apply also to shock-tube investigations. Published experimental shock-tube studies on emissivity measurements of air are summarized. These studies include qualitative spectroscopic research behind shock fronts for selected atomic and molecular systems. A quantitative interpretation is presented of 2-path data for the determination of temperature, concentration, and absolute intensities.

CIT.09:009

California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

SHOCK TUBE STUDIES OF ACETYLENE DECOMPOSITION, by W. J. Hooker. Apr. 1958, 10p. incl. illus. diagrs. (Technical rept. no. 7) (AFOSR-TN-58-293) (AF 18(603)2) AD 154202 Unclassified

Also published in Seventh Symposium (International) on Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, p. 949-952.

Extensive experimental studies were conducted on the rate of decomposition of Ar-acetylene mixtures by means of shock waves. Spectrally integrated radiation measurements in the visible region of the spectrum were made of the simultaneous emission and absorption of the transmitted radiant energy by the heated gases and solid particles behind the incident shock front. Emission from the acetylene $\Sigma_u^+ - \Sigma_g^+$ parallel band at 3287 cm^{-1} was recorded concurrently. Activation energies of 26 and 33 kcal/mol respectively, were found for the first- and second-order, decomposition reactions of acetylene. Measurements were made of the induction time for incipient formation from Ar-acetylene mixtures. Tests were conducted to determine if impurity or inert gas radiation contributed to the measured emission. No radiation was detected in the visible or IR regions of the spectrum. There was no measurable scattering at right angles to the chopped transmitted radiation in the visible region.

CIT.09:010

California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

SPECTROSCOPIC STUDIES OF HEATED SALTS BEHIND SHOCK FRONTS, by H. Takeyama and V. C. D. Dawson. Nov. 1958 [27]p. incl. diagrs. table. (Technical rept. no. 8) (AFOSR-TN-58-1079) (AF 18(603)2) AD 207589; PB 138350 Unclassified

The spectra of heated solids behind shock fronts are similar to spark and arc spectra and are strongly dependent upon the shock conditions. Experimental studies of emission intensities as a function of time indicate that excessive cooling occurs in the shock tube and that population temperatures of electronically excited atoms and positive ions cannot be determined reliably. (Contractor's abstract)

CIT.14:001

California Inst. of Tech. [Mechanical Engineering Lab.] Pasadena.

ELASTIC CONSTANTS OF ZINC SINGLE CRYSTALS (Abstract), by M. Croutzeilles and E. A. Stern. [1957] [1]p. [AF 18(600)1561] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bul. Amer. Phys. Soc., Series II, v. 2: 213-214, Apr. 25, 1957.

The five elastic constants of zinc single crystals have been measured from liquid nitrogen to room temperature. An ultrasonic resonance technique with electrostatic drive, similar to that of Pursey and Pyatt, is utilized. The electrostatic drive does not require mechanical contact between exciter and specimen, and thus is particularly suitable for measurements as a function of temperature since there is no stress produced by differential thermal expansion between the specimen and exciter. The problem of the propagation of elastic waves along an infinite cylinder composed of an anisotropic hexagonal crystal whose c axis is also the axis of the cylinder was solved exactly. Using this solution, it is possible in principle to measure all five elastic constants of a hexagonal crystal by measuring the variation of velocity of longitudinal waves as a function of frequency. In practice three constants were obtained this way, while the other two were obtained by measurements on two other differently oriented crystals.

CIT.14:002

California Inst. of Tech. [Mechanical Engineering Lab.] Pasadena.

TEMPERATURE VARIATION OF ELASTIC CONSTANTS

CIT.14:003, 004; CIT.15:001, 002

(Abstract), by E. A. Stern. [1957] [1]p. [AF 18(600)-1561]
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 214,
Apr. 25, 1957.

By considering the quantum mechanical behavior of a particle acted upon by an anharmonic potential well, a method is developed which permits the calculation of the temperature variation of the adiabatic elastic constants. This method is applicable to any solid, since it does not require central forces between atoms. It is in contrast to the method of Born and his collaborators which assumed a special central force between atoms. Using the calculation of Fuchs on the elastic constants of Na and Li, the temperature variations of the adiabatic elastic constants of Na and Li are calculated from 0°K to room temperature, neglecting their respective allotropic transformations at 32°K and 78°K. The calculation for Na is compared with experiment in the temperature range of the measurements.

CIT.14:003

California Inst. of Tech. Mechanical Engineering Lab.,
Pasadena.

THEORY OF THE ANHARMONIC PROPERTIES OF
SOLIDS, by E. A. Stern. June 1958 [47]p. incl. diagrs.
tables, refs. (Technical rept. no. 1) (AFOSR-TN-58-
563) (AF 18(600)1561) AD 158381 Unclassified

Also published in Phys. Rev., v. 111: 786-797, Aug. 1,
1958.

A theory is presented which includes the anharmonic terms in the expansion of the lattice vibrations. This theory can be used to calculate the anharmonic properties of solids such as the thermal expansion coefficient, the temperature dependence of elastic constants, the dependence of elastic constants under stresses, and the deviation of the specific heat from the Dulong-Petit law at high temperatures. The theory is applied to sodium under the assumption of a special force interaction between nearest neighbors only. Three parameters are obtained from experimental measurements of the elastic constants near 0°K, the temperature dependence of the compressibility, and the thermal expansion. From this the variation of the volume with pressure, and the deviation of the specific heat from the Dulong-Petit law at high temperatures are calculated and are found to be in satisfactory agreement with experiments. The temperature derivative of the compressibility is calculated to be proportional to the specific heat and is found to be in satisfactory agreement with the experimental measurements for sodium.

CIT.14:004

California Inst. of Tech. [Mechanical Engineering Lab.]
Pasadena.

EXACT SOLUTION OF LONGITUDINAL ACOUSTIC
WAVES PROPAGATING ALONG AN ANISOTROPIC
CYLINDER, by E. A. Stern. Jan. 1959, 14p. incl. diagrs.
(Technical rept. no. 2) (AFOSR-TN-58-1053) (AF 18-
(600)1561) AD 206981 Unclassified

Exact solutions are obtained for the problem of axially symmetric longitudinal elastic waves propagating along a cylinder composed of a hexagonal crystal whose c-axis is along the cylinder axis. It is shown that the solutions for this particular anisotropic case have qualitatively the same type of modes of propagation as in the isotropic case of the Pochhammer-Chree solutions. Good agreement between theory and experiment is obtained for the velocity as a function of wavelength. (Contractor's abstract)

CIT.15:001

California Inst. of Tech. Palomar Observatory, Pasadena.

THE HELIUM-RICH STAR, SIGMA ORIONIS E, by J. L.
Greenstein and G. Wallerstein. July 24, 1957 [9]p.
incl. tables. (Technical rept. no. 1) (AFOSR-TN-57-490)
(In cooperation with Carnegie Inst. of Washington, D. C.,
Mount Wilson Observatory, Calif.) (AF 49(638)21)
AD 136663 Unclassified

Also published in Astrophys. Jour., v. 127: 237-240,
Jan. 1958.

The great strength of the helium lines and the existence of a helium absorption discontinuity in the star σ Orionis E (HD 37479) were both announced by Berger (1956). It is the purpose of this note to present an illustration of the spectrum, demonstrate that it is a member of the multistar system σ Orionis, and determine its absolute magnitude and position in the color-magnitude diagram.

CIT.15:002

California Inst. of Tech. Palomar Observatory, Pasadena.

DOUBLE ABSORPTION LINES IN THE SPECTRUM
OF R ANDROMEDAE, by P. W. Merrill and J. L.
Greenstein. Oct. 24, 1957, 4p. incl. tables. (AFOSR-TN-
57-639) (AF 49(638)21) AD 210894 Unclassified

Also published in Astron. Soc. of the Pacific, v. 70: 98-
101, Feb. 1958.

An infrared spectrogram of the red star R Andromedae shows that many of the absorption lines have two narrow components. The shorter wavelength line corresponds to a differential radial velocity of 23 km/sec ($\Delta\lambda = 0.6\text{\AA}$).

CIT.15:003 - CIT.15:006

Tabular data of the radial velocity and spectral intensity ratio of the multiple lines is supplied. A search of the 1954 and 1956 spectra has been carried out for zero volt excitation-potential lines, and a comparison of the observed line occurrence with occurrence expected by chance line position indicates that the displaced components do occur but are not universally present. An expanding stellar shell is strongly suggested but is not conclusive.

CIT.15:003

[California Inst. of Tech. Palomar Observatory, Pasadena.]

DYING STARS, by J. L. Greenstein. [1959] [8]p. incl. diagrs. (AFOSR-TN-58-218) [AF 49(638)21]

Unclassified

Published in Scientific American, v. 200: 46-53, Jan. 1959.

A review is presented of the theoretical knowledge and speculation concerning the formation, evolution, and composition of white dwarf stars. The evolution of a star from the main sequence to the white dwarf stage is outlined. Specific examples from among the group of about 80 white dwarf stars already studied are presented to illustrate aspects of the theory.

CIT.15:004

California Inst. of Tech. Palomar Observatory, Pasadena.

A 21-cm SURVEY AROUND THE PLEIADES, by H. L. Helfer and H. E. Tatel. [1959] [18]p. incl. diagrs. tables, refs. (AFOSR-TN-58-727) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 249555

Unclassified

Also published in Astrophys. Jour., v. 129: 565-582, May 1959.

A detailed 21-cm survey has been made of the interarm region $3^h 15^m - 4^h 15^m$ from $+21^\circ$ to $+37^\circ$ declination. The presence of parts of a half-dozen separate gas aggregates is noted, and some crude mass estimates are given. Attention is drawn to the probable existence of low-intensity signals with Doppler widths less than the band pass of the receiver $\sim 1\frac{1}{2}$ km/sec. No correlation between the 21-cm observations and the obscuring dust is found. No appreciable amounts of gas need to be associated with the Pleiades or the ξ Persei cluster or with any other extended optical feature in the field. (Contractor's abstract)

CIT.15:005

California Inst. of Tech. Palomar Observatory, Pasadena.

THE ATMOSPHERE OF THE WHITE DWARF VAN MAANEN 2, by V. Weidemann. [1960] [26]p. incl. diagrs. tables, refs. (AFOSR-TN-58-728) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 249555

Unclassified

Also published in Astrophys. Jour., v. 131: 638-663, May, 1960.

The spectrum of the white dwarf van Maanen 2, which contains only strongly broadened and blended ultraviolet iron lines and the H and K lines of Ca II, has been analyzed. Model-atmosphere calculations have been carried through for three different effective temperatures with corresponding values for the gravity ($\theta_e = 0.76, 0.87, \text{ and } 1.0; \log g = 8.4, 8.0, \text{ and } 7.5$). If the dependence on depth of the line-formation process is taken into account, the ultraviolet spectrum can be successfully understood. The symmetry of the individual profiles indicates that impact-pressure broadening due to van der Waals forces is the main damping mechanism. The gas pressure derived from the observed damping constants is found to be approximately 2000 atm, which is more than a hundred times the value expected for a model with the assumed surface gravity and with normal (main-sequence) abundances. An investigation of the dependence of pressure on both hydrogen and metal abundances and an evaluation of the central intensities of the lines show that, in order to account for the pressure excess the hydrogen abundance (ϵ_H) must be reduced to $\log \epsilon_H = -1.75$ and the metal content (ϵ_M) must be diminished by $\Delta \log \epsilon_M = -3.9$ as compared with that of the sun. If molecule formation is taken into consideration, the figures are changed to $\log \epsilon_H = -1.65, -1.16, \text{ or } -0.43$, and $\Delta \log \epsilon_M = -3.6, -3.9, \text{ or } -4.2$ for $\theta_e = 0.76, 0.87, \text{ or } 1.0$. The color and excitation favor $T_e = 5800^\circ$ ($\theta_e = 0.87$) as the most probable value of the effective temperature. (Contractor's abstract)

CIT.15:006

California Inst. of Tech. Palomar Observatory, Pasadena.

ABUNDANCES IN G DWARF STARS. I. A COMPARISON OF TWO STARS IN THE HYADES WITH THE SUN, by G. Wallerstein and H. L. Helfer. [1959] [9]p. incl. diagrs. tables, refs. (AFOSR-TN-58-785) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 202111

Unclassified

CIT. 15:007-009; CAL. 07:001

Also published in *Astrophys. Jour.*, v. 129: 347-355, Mar. 1959.

A curve-of-growth analysis has been used to compare abundances in two G dwarfs of the Hyades with those of the sun. The abundances of Na, Mg, Si, Ca, Sc, Ti, Cr, Mn, Fe, and Ni are found to be the same as in the sun within 25 per cent. Ba is overabundant by a factor of 2. The results can be interpreted in either of two ways. If the overabundance of Ba is spurious, then it seems most likely that the enrichment of the interstellar medium between presolar times and the time of formation of the Hyades stars has been negligible. On the other hand, if Ba is indeed overabundant, then the material that has enriched the interstellar medium must have had the solar abundance of the other ten elements studied. By considering the processes discussed by Burbidge et al (*Rev. Modern Phys.*, v. 29: 547, 1957) it can be shown that Ba and other very heavy elements can be overabundant if the material had been subjected to a temperature of 10^8 degrees but no greater. (Contractor's abstract)

CIT.15:007

California Inst. of Tech. Palomar Observatory,
Pasadena.

SHARP LINES IN THE SPECTRUM OF NOVA RS OPHIUCHI, by G. Wallerstein. Oct. 24, 1957, 10p. incl. table. (AFOSR-TN-58-821) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(838)21) AD 202905 Unclassified

Also published in *Astron. Soc. of the Pacific*, v. 70: 537-543, Dec. 1958.

The spectral history of the nova from 14 July 1958 up to 30 July 1958 as obtained by the author at the Mount Wilson Observatory is presented. The spectral data includes absorption lines obtained by use of the 60 inch telescope at Mount Wilson as well as the 100 and 200 inch telescopes at Palomar, as well as the calculated radial velocity of the emitting gases. The spectral absorption data is used to investigate the presence of a pre-existing stationary circumstellar gas envelope surrounding the nova star. The data seem to be unexplainable in terms of a model in which the radial velocity and density of the gases are a function of the radial position alone.

CIT.15:008

California Inst. of Tech. Palomar Observatory,
Pasadena.

ABUNDANCES IN G DWARF STARS. II. THE HIGH-VELOCITY STAR 85 PEGASI, by G. Wallerstein and H. L. Helfer. [1959] [4]p. incl. diagr. tables, refs. (AFOSR-TN-58-928) (In cooperation with Mount

Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 228275 Unclassified

Also published in *Astrophys. Jour.*, v. 129: 720-723, May 1959.

A curve-of-growth analysis, using the same methods as those used in Paper I (Item no. CIT.15:006) on the Hyades, yields the following results for 85 Pegasi relative to the sun. The abundance of nine elements from sodium to nickel are down by a factor of 3. Manganese is weak by a factor of 9, and barium is weak by a factor of 5. The underabundance of manganese and barium can be understood in terms of the process discussed by Burbidge et al (*Rev. Modern Phys.*, v. 29: 547, 1957). (Contractor's abstract)

CIT.15:009

[California Inst. of Tech. Palomar Observatory,
Pasadena.]

VELOCITY CHANGES OF CHARGED PARTICLES IN A PLASMA, by F. D. Kahn. [1959] [7]p. incl. table. (AFOSR-TN-58-929) (In cooperation with Inst. for Advanced Study, Princeton, N. J. and Mount Wilson Observatory, Pasadena, Calif.) (AF 49(838)21) AD 204735 Unclassified

Also published in *Astrophys. Jour.*, v. 129: 468-474, Mar. 1959.

A comparison is made of the different ways in which an ionized gas may change the velocities of fast-moving protons. It is found that a beam with a very well-defined velocity may lose its kinetic energy through the excitation of unstable oscillations, but it seems most unlikely that the stringent conditions necessary for this process will ever occur in any astrophysical application. Bohm and Pines have shown (*Phys. Rev.*, v. 85: 338, 1952) that, single protons lose energy by leaving a wake in the plasma. If sufficiently intense plasma oscillations are excited, the protons may also gain energy through acceleration in random electric fields. Fast electrons can be accelerated even more efficiently in this way. (Contractor's abstract)

CAL.07:001

California U. [Dept. of Chemistry] Berkeley.

INFRARED ABSORPTION BY THE N_3 RADICAL, by D. E. Milligan, H. W. Brown, and G. C. Pimentel. [1956] [1]p. [AF 49(638)1] Unclassified

Published in *Jour. Chem. Phys.*, v. 25: 1080, Nov. 1956.

Aside from the intrinsic interest in the infrared spectrum of a free radical, the results given in this paper may have

CAL.07:002 - CAL.07:004

important bearing on the results of Broida et al. The apparent stability of N_3 radical in the condensed solid makes it less likely that nitrogen atoms are trapped in the solid nitrogen. It is not expected that there would be sufficient activation energy retarding the reaction $N + N_2 = N_3$ to permit both N and N_3 to be present in solid nitrogen. Furthermore, the reactions of formation and loss of N_3 radicals may play a role in the glow phenomena.

CAL.07:002

California U. Dept. of Chemistry, Berkeley.

MATRIX ISOLATION STUDIES. I. INFRARED STUDIES OF HYDROGEN BONDING OF WATER BY THE MATRIX ISOLATION TECHNIQUE, by M. Van Thiel, E. D. Becker, and G. C. Pimentel. II. REACTION KINETICS BY THE MATRIX ISOLATION METHOD: DIFFUSION IN ARGON; cis-trans ISOMERIZATION OF NITROUS ACID, by G. C. Pimentel. June 15, 1957, 1v. incl. diagrs. table, refs. (AFOSR-TN-57-328) (AF 49(638)1) AD 132401

Unclassified

Pt. I also published in Jour. Chem. Phys., v. 27: 486-490, Aug. 1957. Pt. II also published in Jour. Amer. Chem. Soc., v. 80: 62-64, Jan. 5, 1958.

Part I. The stretching and bending vibrational modes of the hydrogen bonded polymers of water have been studied by the matrix isolation technique using solid nitrogen at 20°K as a matrix. Absorptions are assigned to water monomers (3725, 3633 and 1600 cm^{-1}), to dimers (3691, 3546 and 1620 cm^{-1}) and to higher polymers (3510, 3365, 3318, 3222 and 1633 cm^{-1}). The frequencies suggest that the dimers have cyclic rather than open (or bifurcated) structures. The absorption coefficients of the bending modes decrease slightly in the higher polymers while those of the stretching mode increase by a factor of about twelve. This intensity behavior cannot be explained solely on the basis of enhanced ionic character of the O-H group in the hydrogen bond. Part II. The use of the matrix isolation technique for the study of reaction rates of chemical reactions with heats of activation as low as one or two kcal is described. Reactions which might be studied include isomerization, bond rupture, bond formation reactions and the process of diffusion in the solid matrix. A crude estimate of the rate of diffusion of ammonia in solid argon is presented. The heat of activation of the isomerization of cis-HNO₂ to trans-HNO₂ was measured at 20°K in solid nitrogen and found to be much lower than current estimates.

CAL.07:003

California U. Dept. of Chemistry, Berkeley.

MATRIX ISOLATION STUDIES: INFRARED SPECTRA OF INTERMEDIATE SPECIES IN THE PHOTOLYSIS OF HYDRAZOIC ACID, by E. D. Becker, G. C. Pimentel, and M. Van Thiel. [1957] [6]p. (AF 49(638)1)

Unclassified

Published in Jour. Chem. Phys., v. 26: 145-150, Jan. 1957.

The matrix isolation method has been used to investigate the photolysis of hydrazoic acid (HN₃) suspended in xenon, argon, and nitrogen matrices at 20°K. Infrared spectra of the photolyzed material in argon and nitrogen matrices show absorption bands of NH₃ and a number of other prominent spectral features that are probably due to unstable molecules, including intermediates in the formation of NH₃. In a xenon matrix no new bands are observed on photolysis of HN₃ at 20°K, but the presence of the imine radical (NH), or of nitrogen and hydrogen atoms, is inferred from the formation of NH₄N₃ when the material is warmed to 70°K. The mechanism of photolytic production of radicals in a matrix is examined, and the probably importance of the heat of fusion of the matrix is discussed. The utility of the matrix isolation technique in the infrared study of unstable reaction intermediates is demonstrated. (Contractor's abstract)

CAL.07:004

California U. Dept. of Chemistry, Berkeley.

INFRARED STUDIES OF HYDROGEN BONDING OF METHANOL BY THE MATRIX ISOLATION TECHNIQUES, by M. Van Thiel, E. D. Becker and G. C. Pimentel. [1957] [5]p. (AF 49(638)1) Unclassified

Published in Jour. Chem. Phys., v. 27: 95-99, July 1957.

The O-H stretching mode of hydrogen bonded methanol has been studied by the matrix isolation technique using solid nitrogen at 20°K as a matrix. The bands are narrow and permit assignment of absorptions at 3660, 3490, 3445, 3290, and 3250 cm^{-1} to the species, respectively, monomer, dimer, trimer, tetramer, and higher polymers. The results correlate with the room temperature concentration dependence of the H bonded O-H stretching mode of methanol in solution. The dependence of frequency upon polymer size suggests that methanol dimers and trimers have cyclic structures and higher polymers have open (chain) structures. In the cyclic structures, the strain associated with the bent H bond is assumed to account for the low-frequency shift of dimers and trimers compared to higher polymers. (Contractor's abstract)

CAL. 07:005-008; CAL. 08:001

CAL.07:005

California U. [Dept. of Chemistry] Berkeley.

MATRIX ISOLATION METHOD: SOME STUDIES BY ELECTRONIC SPECTROSCOPY (Abstract), by S. Leach. [1957] [1]p. (AF 49(638)1) Unclassified

Published in Program for Symposium on The Formation and Stabilization of Free Radicals, Nat'l. Bur. Standards, Washington, D. C. (Sept. 18-20, 1957), Washington, Nat'l. Bur. Standards, 1957, p. R1.

A low temperature cell for the study of the UV and visible absorption spectra of free radicals is described. In the experiments the radicals are produced by UV photolysis or by an electric discharge and they are isolated by means of the matrix method. During a single experiment, spectra may be taken over the ranges 1850A to 13μ, 2100A to 15μ, or 2300A to 25μ by suitable modifications of the apparatus. The experimental problems involved and the advantages of the quasi-simultaneous study by electronic and IR spectroscopic techniques are discussed. The possibilities and usefulness of an extension of the method to photolysis by far UV radiation are considered.

CAL.07:006

California U. Dept. of Chemistry, Berkeley.

MATRIX ISOLATION STUDIES. 1. THE PHOTOLYSIS OF NITROMETHANE AND OF METHYL NITRITE IN AN ARGON MATRIX; INFRARED DETECTION OF HNO, by H. W. Brown and G. C. Pimentel. May 10, 1958, 19p. incl. tables, refs. (AFOSR-TN-58-429) (AF 49(638)1) AD 158232 Unclassified

Also published in Jour. Chem. Phys., v. 29: 883-888, Oct. 1958.

The photolysis of nitromethane in solid argon at 20°K gives methyl nitrite. All other products can be explained in terms of the secondary photolysis of methyl nitrite. This work provides a definitive basis for segregating the vibrational frequencies of the *cis*- and *trans*- isomers of methyl nitrite. The primary products of photolysis of methyl nitrite under these conditions are formaldehyde and nitroxyl, HNO. The identification of HNO, detected by its infrared spectrum for the first time, is confirmed by the band shifts occurring upon deuteration. The vibrational frequencies of HNO (1570 and 1110 cm⁻¹) and DNO (1560 and 822 cm⁻¹) correspond to a bent molecule with a double bond between the nitrogen and oxygen atoms, thus supporting the structure HNO over the possible arrangement HON. The bending force constant, 0.67·10⁻¹¹ dyne-cm, suggests that the HNO angle is near 110°, larger than the earlier estimate of 102° based on electronic spectra. (Contractor's abstract)

CAL.07:007

California U. Dept. of Chemistry, Berkeley.

MATRIX ISOLATION STUDIES: POSSIBLE INFRARED SPECTRA OF ISOMERIC FORMS OF DIAZOMETHANE AND OF METHYLENE. CH₂, by D. E. Milligan and G. C. Pimentel. Sept. 10, 1958, 19p. incl. tables, refs. (AFOSR-TN-58-818) (AF 49(638)1) AD 202643 Unclassified

Also published in Jour. Chem. Phys., v. 29: 1405-1412, Dec. 1958.

The photolysis of diazomethane has been studied by the matrix isolation method. Argon and nitrogen matrices were used at 20°K. There is distinct infrared spectral evidence that unstable species have been detected spectroscopically: the production of stable products is inhibited until diffusion is permitted and a red glow accompanies diffusion. Among the identified products produced during diffusion are ethylene, propylene, methane, and polyethylene. The data suggest that methylene is present as well as a tautomeric structure of diazomethane. One of the absorptions observed at 1362 and 1114 cm⁻¹ could be the bending mode of CH₂. (Contractor's abstract)

CAL.07:008

California U. Dept. of Chemistry, Berkeley.

THE PROMISE AND PROBLEMS OF THE MATRIX ISOLATION METHOD FOR SPECTROSCOPIC STUDIES, by G. C. Pimentel. [1958] [3]p. [AF 49(638)1] Unclassified

Published in Spectrochimica Acta, v. 12: 94-96, Mar.-Apr. 1958.

A variety of types of study were made possible by the matrix technique. These studies include: (1) Band narrowing; (2) Free radicals; (3) Primary act of photolysis; and (4) Kinetics. Examples are also given for each of these studies. In attempting to exploit the possible applications of the matrix technique, a variety of practical and interpretive difficulties have been discovered. Two of these problems are discussed. The matrix isolation method has wide and interesting applications, particularly with infrared spectral techniques.

CAL.08:001

California U. Dept. of Chemistry, Berkeley.

A SIMPLE MOLECULAR ORBITAL TREATMENT OF HYPERCONJUGATION, by A. Streitwieser, Jr. and P. M. Nair. July 1, 1958, 38p. incl. diagrs. tables, refs. (AFOSR-TN-58-590) (AF 49(638)105) AD 162114 Unclassified

CAL.02:008, 009; CAL.09:001, 002

Also published in Tetrahedron, v. 5: 149-165, Jan. 1959.

Also published in Conf. on Hyperconjugation, Indiana U., Bloomington (June 2-4, 1958), N. Y., Pergamon Press, 1959, p. 57-73.

A modification of the simple molecular orbital theory has been successfully applied to the treatment of ionization potentials of unsaturated molecules. Of the several models examined for the hyperconjugative effect of a methyl group, best results were obtained for a model in which the methyl group is treated as a single "heteroatom," which donates two electrons to the π -system. (Contractor's abstract)

CAL.02:008

California U. Dept. of Mathematics, Berkeley.

APPROXIMATE SOLUTIONS OF PARABOLIC AND HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS, by M. Lee. Oct. 1957, 83p. refs. (Technical rept. no. 7) (AFOSR-TN-57-777) (AF 18(600)1117) AD 146093 Unclassified

An investigation is made of the approximate solutions of certain mixed initial-boundary value problems for nonlinear parabolic and hyperbolic partial differential equations. Two methods of implicit approximation are discussed. The first method replaces the first boundary-value problem for the partial differential equation by an initial value problem for a nonlinear system of ordinary differential equations. The second method leads to boundary-value problems for nonlinear partial difference equations over a rectangular lattice. In both cases, the properties for the approximate solutions are established which are analogous to properties of exact solutions. On the basis of these derived estimates, theorems concerning the relationship between the approximate and exact solutions are derived.

CAL.02:009

California U. Dept. of Mathematics, Berkeley.

LOWER BOUNDS FOR THE FIRST EIGENVALUE OF ELLIPTIC EQUATIONS AND RELATED TOPICS, by M. H. Protter. June 1958, 25p. (Technical rept. no. 8) (AFOSR-TN-58-434) (AF 18(600)1117; continued by AF 49(638)398) AD 158238 Unclassified

A general method is described which yields a lower bound for the first eigenvalue, for any second order elliptic equation with any bounded domain. The results of the method for the membrane equation are applied to the case of the rhombus and triangle, and a comparison is made of their lower bounds by the method of symmetrization. A natural extension is given of the method of arbitrary functions to the case of three functions. The discussion is limited to the membrane equation

and a simple example is given. The general comparison theorems of Bocher for ordinary differential equations are extended to partial differential equations. The method of symmetrization is extended to the general linear elliptic second order equation to yield lower bounds for the first eigenvalue in the most general case.

CAL.09:001

California U. Dept. of Mathematics, Berkeley.

THE SUSPENSION OF THE GENERALIZED PONTRJAGIN COHOMOLOGY OPERATIONS, by E. Thomas. Oct. 1957, 25p. (Technical rept. no. 1) (AFOSR-TN-57-858) (AF 49(638)79) AD 135650 Unclassified

Also published in Pacific Jour. Math., v. 9: 897-911, Fall 1959.

Let $A = \sum_k A_k$ be a graded ring with divided powers such that each A_k is a cyclic group of infinite or prime power order (p -cyclic ring). The Pontrjagin operators are functions β_t such that

$$H^{2n}(X; A_{2k}) = H^{2n}(X; A_{2k}) \text{ for all } k, n > 0 \text{ and}$$

$t = 0, 1, \dots$, where $H^q(X, Y; G)$ denotes the functor which

assigns to each pair of spaces (X, Y) its q^{th} cohomology group with coefficients in the group G . Let $S(A)$ be the suspension operator for the cohomology operator A . Let β be the Postnikov square cohomology operator such that

$$\beta : H^q(X, Y; A_{2k}) \rightarrow H^{2q+1}(X, Y; A_{4k}), \text{ where}$$

A_{2k} is an even summand of a p -cycle ring with divided

powers. The following theorem is the main result of

this paper: for any cohomology operator β and $S(\beta)$

the suspension operator, then $S(\beta_t) = \beta$ and $S(\beta_t) = 0$

for $t > 2$, where 0 denotes the zero cohomology operator.

Two new properties for the operator β are given:

(1) $\beta(\beta(u)) = 0$, and (2) if the order of $A_{2k} = 2^l$ with

$(l > 1)$ and $2u = 0$ then $\beta(u) = 0$ provided that $u \in H^q(X; A_{2k})$.

CAL.09:002

California U. Dept. of Mathematics, Berkeley.

THE FUNCTIONAL PONTRJAGIN COHOMOLOGY OPERATIONS, by E. Thomas. Oct. 1957 [11]p. (Technical rept. no. 3) (AFOSR-TN-57-893) (Bound with its AFOSR-TN-57-895; Technical rept. no. 2; AD 138717) (AF 49(638)79) AD 136686 Unclassified

Also published in Bol. Soc. Matem. Mexicana, Serie II, v. 3: 19-24, Apr. 1958.

An example is given of a non-trivial functional operator associated with the general Pontrjagin cohomology operator. It is a mapping of the sphere S^{2p-1} onto the

CAL.09:003 - CAL.09:005

complex projection space M_{p-1} . The operator associated with \mathbb{P} of the generator of $H^2(M_{p-1}; \mathbb{Z})$ generates the cohomology group of the sphere. The cohomology group can also be obtained by the functional cup-product. If a 3-cell is attached to S^2 in M_{p-1} , then it is found that map of S^{2p-1} into the $(2p-2)$ -space is essential. The above can be obtained by means of the operator associated with \mathbb{P} but the functional cup-product does not provide a solution.

CAL.09:003

California U. Dept. of Mathematics, Berkeley.

A NOTE ON NON-STABLE COHOMOLOGY OPERATIONS, by F. Peterson and E. Thomas. Oct. 1957, 12p. (Technical rept. no. 2) (AFOSR-TN-57-695) (Bound with its AFOSR-TN-57-693; Technical rept. no. 3; AD 136686) (AF 49(638)79) AD 136717 Unclassified

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 3: 13-18, Apr. 1958

Let θ be a primary cohomology operator of the type $(\pi, n; G, p)$ and f a continuous map of the space X into the space Y . Let θ_f be a functional cohomology operator such that $\theta_f(u)$ is a subset of $H^{q-1}(Y; G)$. If θ is an additive cohomology operator (homomorphism), then $\theta_f(u)$ is a coset of the subgroup of $L(\theta, f) = f^*(H^{q-1}(X; G)) + {}^1\theta(H^{n-1}(Y; \pi))$ where ${}^1\theta$ is an operator of the type $(\pi, n-1; G, q-1)$ and is called the suspension of θ . When θ is additive, θ_f maps on cosets of $H^*(Y; G)$ modulo a subgroup $L(\theta, f)$. It is shown that for all operators θ , the subset $\theta_f(u)$ is in fact a coset of the subgroup $L(\theta, f)$ and in all cases $\theta_f(u)$ is to be regarded as an element of the quotient group $H^{q-1}(Y; G)/L(\theta, f)$. This result is shown to be true in the two following cases: (1) even if the additive property holds only for elements of the form $\theta(v + \delta w) = \theta(v) + \theta(\delta w)$, where δ is the coboundary operator such that if $x \in H^{q-1}(Y; G)$, then $\delta(x) = \theta(v)$; and (2) using the Peterson definition of the functional cohomology operations.

CAL.09:004

California U. [Dept. of Mathematics] Berkeley.

THE GENERALIZED PONTRJAGIN COHOMOLOGY OPERATIONS AND RINGS WITH DIVIDED POWERS, by E. Thomas. [1957] 82p. Incl. diagrs. refs. (AFOSR-TN-57-770) (AF 49(638)79) AD 149742 Unclassified

Also published in Mem. Amer. Math. Soc., No. 27, 1957, 82p.

The theory of Pontrjagin square cohomology operations is given, which generalizes the "Pontrjagin square." $\Gamma(R)$ is taken as the category of graduated rings A with divided powers. There are applications γ_r ($r = 0, 1, 2, \dots$)

which, for all integral $k \geq 1$, put A_{2k} into A_{2rk} , with conditions: $\gamma_0(x) = 1$, $\gamma_1(x) = x$, $\gamma_r(x)\gamma_s(x) = (r, s)\gamma_{r+s}(x)$, $\gamma_r(x+y) = \sum_{s+t=r} \gamma_s(x)\gamma_t(y)$, $\gamma_s(\gamma_r(x)) = \epsilon_{s,r}\gamma_{sr}(x)$ for $s > 0$, $r > 0$, $\gamma_r(xy) = r! \gamma_r(x)\gamma_r(y)$ for x and y of equal degrees ≥ 2 , $\gamma_r(xy) = 0$ for x, y of unequal degrees and $r \geq 2$; $(r, s) = (r+s)!/r!s!$, and

$\epsilon_{s,r} = \prod_{i=1}^s (ir, r-1)$. The morphisms of the category $\Gamma(R)$ are defined in an evident manner. A given whole prime p is considered which is bounded on the sub-category $\Gamma_p(R)$ formed from A such that, for all $n \geq 1$, A_n is an infinite cyclic group or of order equal to a power of p . The cohomology of the space (or simplicial set) X with coefficients in an $A \in \Gamma_p(R)$ is considered. Various definitions, terminology, and alternative methods are studied and described.

CAL.09:005

California U. [Dept. of Mathematics] Berkeley.

ON HOLONOMY AND HOMOGENEOUS SPACES, by B. Kostant. [1957] [24]p. [AF 49(638)79] Unclassified

Published in Nagoya Jour. Math., v. 12: 31-54, Dec. 1957.

Let G be a compact connected Lie group and K a closed subgroup. The purpose of this paper is mainly to consider questions of holonomy when G/K is provided with an arbitrary invariant metric, not necessarily a natural one, and to see how reducibility properties change when we change from one metric to another. In section 2 of this paper the author proves: Let G/K be given any homogeneous Riemannian metric. Let g and k be respectively Lie algebras of G and K , and let p be any complement to k such that p admits a strictly invariant bilinear form (X, Y) . Let (X, Y) be the bilinear form on p given by the metric tensor. Let $S: p \rightarrow p$ be defined by $(SX, Y) = (X, Y)$. Extend S to g by defining $S = 0$ on k . Now for any $Z \in g$ let D_Z be the operator on p defined by $D_Z Y = [Z, Y]_p$ for all $Y \in p$. Then the linear holonomy algebra is the Lie algebra generated by all operators on p of the form $D_Z + S^{-1}D_Z S - S^{-1}D_{SZ}$, where $Z \in g$. At the beginning of section 3, the author gives an example of a case where g or G is simple yet G/K is reducible, which is a counter-example to the conjecture of Nomiau. In the later part

CAL.09:006 - CAL.09:007

of section 3 he proves the following two theorems and determines the linear holonomy group and the linear holonomy algebra for an arbitrary invariant metric. (1) Let C be an arbitrary permissible metric (that is, a positive definite bilinear form on p which is invariant under $\text{ad}_p K$). Let $s_0(C)$ be the corresponding holonomy algebra, so that $\exp s_0(C) = \tau_0(C)$ is the restricted linear holonomy group. Let $\psi_0(C)$ be the full linear holonomy group. Then $\text{ad}_p K \subseteq \psi_0(C)$ and in fact $\psi_0(C) = \text{ad}_p(K) \cdot \tau_0(C)$. (2) A subspace $p_1 \subseteq p$ is invariant under $\tau_0(C)$ if and only if it is invariant under $\psi_0(C)$. Furthermore the elements of p_1 are fixed under the action of $\tau_0(C)$ if and only if they are fixed under the action of $\psi_0(C)$. Let B be a strictly invariant bilinear form on p , that is, a positive definite bilinear form on p for which D_X is skew-symmetric for all $X \in g$, and let C be any permissible metric. Let $p = \sum_{i=1}^m p_i(C)$ be the direct sum, where $p_0(C)$ is the set of all vectors in p which are fixed by $\psi_0(C)$, and $p_i(C)$, $i = 1, 2, \dots, m(C)$, are irreducibly invariant subspaces under the action of $\psi_0(C)$. In section 4, the author proves: (1) $C < B$ if and only if S leaves the subspaces $p_i(B)$ invariant, $i = 0, 1, \dots, m(B)$. (2) $B < C$ whenever S leaves the subspaces $p_i(C)$ invariant. Conversely, if $B < C$ we may find a permissible strictly invariant metric B' on p which is strongly equivalent to B and which is such that S' leaves the spaces $p_i(C)$ invariant. (3) If we assume $p \cap c = 0$, where c is the center of g , then $B < C$ if and only if S leaves the subspaces $p_i(C)$ invariant. (4) Assume $\text{ad}_p K$ has inequivalent representations. Then any two permissible metrics C_1 and C_2 are weakly equivalent. That is, the decomposition $p = \sum_{i=1}^m p_i(C)$ is independent of the metric C . Sections 5 and 6 are devoted to the applications of these results. To quote one: Assume $\chi(G/K) \neq 0$ and that g acts effectively on G/K . Then with respect to any invariant metric, G/K is irreducible if and only if g is simple. (Math. Rev. abstract)

CAL.09:006

California U. Dept. of Mathematics, Berkeley.

A FORMULA FOR THE MULTIPLICITY OF A WEIGHT,
by B. Kostant. Apr. 1958, 42p. (Technical rept. no. 4)
(AFOSR-TN-58-315) (AF 49(638)79) AD 154219
Unclassified

Also published in Trans. Amer. Math. Soc., v. 93: 53-73, Oct. 1959.

A proof is given for the following theorem: Let G be a semi-simple Lie algebra with Cartan subalgebra h . Let $I \subseteq h$ be the discrete group of integral linear forms on h . Let P be the partition function on I which assigns to every $\mu \in I$ the number of ways μ can be partitioned into a sum of positive roots (multiplicities are permitted and order is discounted). Let Δ^+ be the set of positive roots and let $g = \sum_{\alpha \in \Delta^+} \alpha$. Let W be the

Weyl group and let $s(\sigma) = g - \sigma(g)$ for any $\sigma \in W$. Then $s(\sigma)$ lies in the cone generated by the positive roots and for $\mu \in I$, $\mu \neq 0$, $P(\mu)$ satisfies the recursive relation $P(\mu) = -\sum_{\sigma \in W} s(\sigma) P(\mu - s(\sigma))$.

Let π be an irreducible representation of G . Write $\pi = \pi_\lambda$ where $\lambda \in I_D$ is the highest weight of π . Let $\nu \in I$ be arbitrary. Let $m_\lambda(\nu) = 0$ in case ν is not a weight of π_λ . Let $m_\lambda(\nu)$ be the multiplicity of the weight ν . The number $m_\lambda(\nu)$ is given by the formula

$$m_\lambda(\nu) = \sum_{\sigma \in W} s(\sigma) P(\sigma(g + \lambda) - (g + \nu)).$$

CAL.09:007

California U. Dept. of Mathematics, Berkeley.

A THEOREM OF FROBENIUS, A THEOREM OF AMITSUR-LEVITSKI AND COHOMOLOGY THEORY, by B. Kostant. July 1958, 52p. (Technical rept. no. 5)
(AFOSR-TN-58-585) (AF 49(638)79) AD 162105
Unclassified

Also published in Jour. Math. and Mech., v. 7: 237-264, Mar. 1958.

The paper is mainly concerned with the following three theorems: (1) the algebra g of all $n \times n$ (complex) matrices satisfies the standard identity of degree $2n$, i.e.

$$[A_1 \dots A_{2n}] = \sum s(\sigma) A_{\sigma(1)} \dots A_{\sigma(2n)} = 0$$

for any $A_i \in g$, where the sum ranges over all permutations σ of $1, \dots, 2n$, and $s(\sigma) = 1$ or -1 according as σ is even or odd; (2) let I be the group algebra of the symmetric group S_{2n+1} and let σ be the cycle

$(1, \dots, 2n+1)$. Then the element $\sum s(\rho) \rho \sigma \rho^{-1}$, where ρ runs over S_{2n+1} , belongs to the 2-sided ideal of I

generated by the element $(\sum \sigma)(\sum s(\tau) \tau)$, where σ runs over all permutations leaving $n+2, \dots, 2n+1$ invariant, while τ runs over all permutations leaving $2, \dots, n+1$ invariant; (3) for the Lie algebra g and an odd integer r , the unique invariant cocycle b_r in the primitive class $P^r(g)$ is given by $\langle b_r, A_1 \wedge \dots \wedge A_r \rangle = \text{tr}[A_1 \dots A_r]$.

where $A_i \in g$. The theorem (1) is due to Amitsur and

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Levitski, theorem (2) is a reformation of a special case of a theorem of Frobenius on the characters of alternating groups, and theorem (3) is due to Dynkin. Theorems (1) and (3) as well as a theorem of Kozul-Samelson on the behavior of primitive cohomology classes of Lie algebras under homomorphisms are derived. It is also shown that the algebra of $n \times n$ skew-symmetric matrices satisfies the standard identity of degree $2n-2$ when n is even. Theorems (1) and (2) are shown to be equivalent by an elementary argument. A new proof of theorem (3) which is independent of theorems (1) and (2) is presented. The proof is based on the onto isomorphisms:

$$\Psi_r: H_r(g) \rightarrow B(H), \quad \Psi^r: B(H) \rightarrow H^r(g),$$

where H is the subspace of all elements of the group algebra 1 of S_r of the form $\sum \text{sg}(\rho) \rho \omega^{-1}$ (the sum runs over all $\rho \in S_r$, and $\omega \in I$), and where B designates the representation of S_r on the space rU of r -tensors over U (the space on which g operates) given by

$$B(\sigma) x_1 \otimes \dots \otimes x_r = x_{\sigma^{-1}(1)} \otimes \dots \otimes x_{\sigma^{-1}(r)}.$$

The above isomorphisms Ψ_r and Ψ^r are obtained by considering the linear mapping η_r defined by

$$\eta_r(A_1 \wedge \dots \wedge A_r) = \frac{1}{r!} \sum A_{\sigma^{-1}(1)} \otimes \dots \otimes A_{\sigma^{-1}(r)},$$

where $A_i \in g$ and the sum ranges over all $\sigma \in S_r$, and by using a theorem of Weyl to the effect that $B(I)$ is the set of all operators on rU which commute with all $A \otimes \dots \otimes A$, where A runs over all nonsingular operators on U .

CAL.09:008

California U. Dept. of Mathematics, Berkeley.

ON THE COHOMOLOGY OF THE REAL GRASSMAN MANIFOLDS AND THE CHARACTERISTIC CLASSES OF n -PLANE BUNDLES, by E. Thomas. July 1958, 66p. (Technical rept. no. 6) (AFOSR-TN-58-600) (AF 49(638)79) AD 162125; PB 138973 Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 67-89, July 1960.

The Pontrjagin squares of the Stiefel-Whitney classes have been determined by W. T. Wu (Trans. Amer. Math. Soc., v. 11: 155-172, 1959). Using this computation, Wu proved that the Pontrjagin classes reduced mod 4 of a differentiable manifold are invariants of the homotopy type of the manifold. In the proof of his formulas, Wu used explicit cellular decompositions of the real Grassman manifolds, and as a result, his proofs are extremely complicated and difficult to follow. In the present paper the author gives a new proof of Wu's above-mentioned results, without the use of any cellular decompositions of the Grassman varieties. He uses only

standard, well known facts regarding the cohomology of the classifying spaces for the orthogonal groups and unitary groups together with the fundamental properties of the Pontrjagin squares in his proof. (Math. Rev. abstract)

CAL.09:009

California U. Dept. of Mathematics, Berkeley.

THE PARTITION FUNCTION FOR CERTAIN SIMPLE LIE ALGEBRAS, by J. Tarski. Aug. 1958, 19p. (Technical rept. no. 7) (AFOSR-TN-58-657) (AF 49(638)79) AD 162188; PB 137580 Unclassified

Explicit expressions are found for the partition function for the following Lie algebras: A_2 , B_2 , G_2 , and A_3 .

CAL.09:010

California U. Dept. of Mathematics, Berkeley.

ON TENSOR PRODUCTS OF n -PLANE BUNDLES, by E. Thomas. Nov. 1958, 52p. (Technical rept. no. 8) (AFOSR-TN-58-1022) (AF 49(638)79) AD 206362; PB 140154 Unclassified

Also published in Arch. der Math., v. 10: 174-179, 1959.

Let η and ζ be respectively r -plane and s -plane bundles over X . Then one may define an rs -plane bundle $\eta \otimes \zeta$ over X , and its Stiefel-Whitney classes are given by a certain polynomial $\Phi_{r,s}$ in the Stiefel-Whitney classes of η and ζ [Borel and Hirzebruch, Amer. Jour. Math., v. 80: 458-538, 1958]. The author gives an elementary proof of this fact. To begin with, the universal example shows that the required classes are given by some such polynomials, say $\Psi_{r,s}$. Next, one can handle the case in which

$r-s=1$ and η, ζ are the standard bundles over $K(Z_2, 1)$.

One can then handle suitable bundles over the product $(K(Z_2, 1))^{r+s}$, and so determine the polynomials $\Psi_{r,s}$. (Math. Rev. abstract)

CAL.09:011

California U. Dept. of Mathematics, Berkeley.

THE PRINCIPLE THREE-DIMENSIONAL SUBGROUP AND THE BETTI NUMBERS OF A COMPLEX LIE GROUP, by B. Kostant. Dec. 1958, 98p. incl. refs. (Technical rept. no. 9) (AFOSR-TN-58-1084) (AF 49(638)79) AD 207581; PB 140700 Unclassified

Also published in Amer. Jour. Math., v. 81: 973-1032, Oct. 1959.

It is impossible to do justice in a brief review to this

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paper which contains a wealth of results dealing with the root structure of Lie groups, the Coxeter-Killing transformation, the reduction of the restriction of the adjoint representation to a 3-dimensional subgroup (3-d.s.) and many related topics. From a well-known theorem of H. Hopf [Ann. of Math., v. 42: 22-52, 1941] it follows that the homology ring of a single Lie group G of rank n is generated by n minimal elements of odd dimension $2m_j + 1$. The integers m_j have been called the exponents of the group. They determine the degrees, $m_j + 1$, of the minimal symmetric invariants of the group, and they also determine, and are determined by, the eigenvalues of γ , the product of n simple reflections which generate the Killing (or Weyl) group. The author proposes, with reason, to call γ the Coxeter-Killing transformation. If, following Steinberg, we define the height of a positive root to be the sum of its coefficients with respect to a basis consisting of simple roots, we may formulate the following theorem: Let the number of positive roots of height 1, 2, ..., h - 1 be p_1, p_2, \dots, p_{h-1} , respectively; then $p_1 \geq p_2 \geq \dots \geq p_{h-1}$, and the partition conjugate to that determined by the p 's consists of the exponents m_j . This result was stated by Robert Steinberg [Trans. Amer. Math. Soc., v. 91: 493-503, 1959], who proved it by verification. It was noticed, independently, by Arnold Shapiro who communicated it privately to the author. The main purpose of the present paper is to prove the above theorem, which is remarkable because of the ease with which it permits the homology ring to be obtained from the root diagram. The proof is effected by establishing a relation (theorem 8.4) between the Steinberg-Shapiro procedure and the eigenvalues of γ and then by appealing to a theorem of the reviewer [Canad. Jour. Math., v. 10: 349-356, 1958], the proof of which is improved in an important respect. In the proof of his central theorem, the author makes much use of the idea of a principal 3-d.s. (due independently to Dynkin and Siebenthal). He shows that the latter is characterized by the following property: the number of irreducible representations obtained when the adjoint representation of G is restricted to a 3-d.s., A, is $\geq n$, with equality if and only if A is principal. Another important result characterizes the Coxeter-Killing transformations: the order of any regular element g of G is \geq the order, h, of γ , with equality if and only if g generates a Coxeter-Killing transformation. Further, the set of all regular elements of G of order h forms a conjugate class. Other results pertain to nilpotent elements and Cartan subgroups. (Math. Rev. abstract)

CAL.10:001

California U. Dept. of Mathematics, Berkeley.

A COMPARISON THEOREM FOR ELLIPTIC EQUATIONS, by M. H. Protter. Sept. 1958, 6p. (Technical rept. no. 1) (AFOSR-TN-58-842) (AF 49(638)398;

 continuation of AF 18(600)1117) AD 203332; PB 138166
Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 296-299, Apr. 1959.

Hartman and Wintner (Proc. Amer. Math. Soc., v. 6: 862, 1955) obtained a Sturmian comparison theorem for self-adjoint second order linear elliptic equations of the form

$$\sum_{i,j=1}^n \frac{\partial}{\partial x_i} (a_{ij} \frac{\partial u}{\partial x_j}) + fu = 0 \quad a_{ij} = a_{ji}$$

in a bounded domain D with boundary Γ . It is the purpose of this note to extend their result to general second order linear elliptic equations.

CAL.10:002

California U. Dept. of Mathematics, Berkeley.

GENERALIZED GOURSAT PROBLEM FOR A HYPERBOLIC SYSTEM, by R. P. Holtan. Dec. 1958, 89p. incl. diagr. refs. (Technical rept. no. 2) (AFOSR-TN-58-1006) (AF 49(638)398) AD 206151; PB 139337
Unclassified

The real linear system of first order hyperbolic differential equations:

$$\sum_{j=1}^N p_{ij}(x,y) V_x^j(x,y) + q_{ij}(x,y) V_y^j(x,y) = \sum_{j=1}^N t_{ij}(x,y) V^j(x,y) +$$

$r_i(x,y)$ $i = 1, \dots, N$ or in vector notation: $PV_x + QV_y = LV + R$, one has the condition:

$$\sum_{j=1}^N e_{ij}(x) V^j(x, z_i(x)) = t_i(x), \quad i = 1, \dots, N \text{ along } \bar{N} \geq N \text{ arcs}$$

emanating from a point (0,0). A resultant system of the form:

$$U_x^i(x,y) + A^i(x,y) U_y^i(x,y) = \sum_{k=1}^N E^{ik}(x,y) U^k(x,y) +$$

$G^i(x,y)$, $i = 1, \dots, N$ with the generalized initial conditions

$$\sum_{j=1}^N \hat{a}^{ij}(x) U^j(x, \hat{y}_i(x)) = H^i(x), \quad i = 1, \dots, N$$

$$\sum_{j=1}^N \hat{a}^{ij}(x) U^j(x, \hat{y}_i(x)) = \hat{H}^i(x), \quad i = 1, \dots, \bar{N}, \quad \bar{N} = N - N_0 - 1.$$

Inequalities are investigated which involve the slopes of the data arcs (from $y = y_1(x)$ or $y = \hat{y}_1(x)$) and the functions A^i (the slopes of the characteristic curves). The consistency of (S_0) at (0,0) is discussed. The existence and

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uniqueness of a solution is proved to (S_0) in the class of first order continuously differentiable functions on a set of sufficiently small diameter, and the existence and uniqueness in the large is established.

CAL.03:009

California U. Dept. of Physics, Berkeley.

CYCLOTRON AND PLASMA RESONANCE IN SOLIDS, by A. F. Kip. [1956] 5p. (AF 18(603)46)

Unclassified

Presented at Conference on Physics of Magnetic Phenomena, Moscow (USSR), May 1956.

The basically different conditions in which cyclotron resonance and plasma resonance occur in semi-conductors are outlined in this review paper. An attempt to short out the plasma effect and the possibility of observing the cyclotron resonance of a minority carrier in the presence of a low mobility, high concentration carrier are discussed. The presence of eddy current losses in a sample in which the carrier density is large enough to render the sample thickness larger than the skin depth seems to eliminate the possibility of observing cyclotron resonance even though plasma resonance is also impossible.

CAL.03:010

California U. Dept. of Physics, Berkeley.

SUSCEPTIBILITY AND CURIE POINT OF MAGNETICALLY DILUTE CRYSTALS, by R. E. Behringer. [1957] [4]p. incl. diagrs. tables. (Technical rept. no. 74) (AFOSR-TN-57-717) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144246

Unclassified

Also published in Jour. Chem. Phys., v. 26: 1504-1507, June 1957.

The Opechowski calculation of the apparent Curie point, T_C , is extended to the case of magnetically dilute fcc crystals. To first order in temperature the result is equivalent to a molecular field treatment. The calculation is carried to fourth order in temperature and a plot is made of T_C vs p , the fractional concentration of magnetic atoms. The theoretical result is compared to some existing experimental data and values of the exchange interaction, J , are estimated. The above calculation is found to be useful only for $0.8 \leq p \leq 1.0$. For low concentrations a crude calculation is made based on clusters of magnetic atoms. To first order in temperature, a linear relationship is found between apparent Curie point and concentration. (Contractor's abstract)

CAL.03:011

California U. Dept. of Physics, Berkeley.

QUADRUPOLE INTERACTION OF NUCLEI WITH CONDUCTION ELECTRONS, by A. H. Mitchell. 1957, 4p. (Technical rept. no. 75) (AFOSR-TN-57-718) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144247

Unclassified

Also published in Jour. Chem. Phys., v. 26: 1714-1717, June 1957.

The nuclear spin-lattice relaxation time in metals is calculated taking into account the following three interactions between the nuclei and the conduction electrons: (1) the usual contact part of the hyperfine interaction, which is the dominant mechanism; (2) the noncontact part of the hyperfine interaction; and (3) the quadrupole interaction for nuclei of spin $I \geq 1$. It is found that the latter two interactions are of the same order of magnitude. If the electronic wave function at the Fermi surface has a p-wave component comparable with its s-wave component, these two mechanisms may appreciably shorten the relaxation time as calculated using only the contact part of the hyperfine interaction. (Contractor's abstract)

CAL.03:012

California U. Dept. of Physics, Berkeley.

FERROMAGNETIC RELAXATION BY THE EXCHANGE INTERACTION BETWEEN FERROMAGNETIC ELECTRONS AND CONDUCTION ELECTRONS, by A. H. Mitchell. Nov. 19, 1956, 6p. incl. refs. (Technical rept. no. 81) (AFOSR-TN-57-719) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144249

Unclassified

Also published in Phys. Rev., v. 105: 1430-1444, Mar. 1, 1957.

The Hamiltonian for the exchange interaction between the ferromagnetic d electrons and the conduction s is derived. The ferromagnetic relaxation time caused by the s-d exchange interaction is calculated in a spin wave approximation. When a screened value of the exchange integral (J atomic/30) is used, the calculated relaxation time for nickel at room temperature is 5×10^{-9} sec as compared to the time 2.5×10^{-10} sec needed to account for the experimental line width. The exchange relaxation may be dominant in materials such as alloys which have narrower lines than nickel. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

ABSORPTION COEFFICIENTS FOR EXCITON ABSORPTION LINES, by G. Dresselhaus. Nov. 26, 1956, 3p. (Technical rept. no. 83) (AFOSR-TN-57-720) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144431

Unclassified

Also published in Phys. Rev., v. 106: 76-78, Apr. 1, 1957.

The absorption coefficient for excitons is calculated in the effective-mass approximation. The coefficient is shown to be decreased over what would be expected for a collection of free atoms by the factor $\epsilon^{-1}(a_0/a_B)^3$, where ϵ is the dielectric constant and a_0/a_B is the ratio of the lattice constant to the exciton radius. This result seems not inconsistent with the identification of the observed absorption line in Cu_2O , CdS , HgI_2 , PbI_2 , and CdI_2 as exciton lines. (Contractor's abstract)

CAL.03:014

California U. Dept. of Physics, Berkeley.

NUCLEAR RELAXATION BY THE HYPERFINE INTERACTION WITH THE ION CORE SPINS IN FERROMAGNETIC AND ANTIFERROMAGNETIC CRYSTALS, by A. H. Mitchell. [1957] 9p. (Technical rept. no. 84) (AFOSR-TN-57-721) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144432

Unclassified

Also published in Jour. Chem. Phys., v. 27: 17-19, July 1957.

The hyperfine interaction of the nucleus with the ion core spins in magnetic crystals provides a relaxation mechanism for the nuclear spins since energy conservation can be obtained by a change in the spin wave energy. In nonconducting magnetic crystals this mechanism may be dominant in the relaxation of the nuclei of the magnetic ions. The relaxation time is calculated for such a nucleus in an antiferromagnetic crystal. (Contractor's abstract)

CAL.03:015

California U. Dept. of Physics, Berkeley.

COPPER NUCLEAR RESONANCE LINE IN CuMn ALLOYS, by R. E. Behringer. [1957] [15]p. incl. table. (Technical rept. no. 85) (AFOSR-TN-57-722) (Spon-

sored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144433

Unclassified

Also published in Jour. Phys. Chem. Solids, v. 2: 209-213, 1957.

The effect of the Mn ion cores on the copper nuclear resonance line in CuMn alloys is investigated. Contributions to the line width and the line shape from magnetic dipolar interaction and indirect exchange coupling are calculated. Comparison is made with the experimental results of Owen, et al (Phys. Rev., v. 102: 1501, 1956). If the ratio of the hyperfine structure splitting in the free atom to that in the crystal is $\xi = 0.53$, the exchange coupling constant A in the crystal must be about twice the free atom value to account for the observed broadening. (Contractor's abstract)

CAL.03:016

California U. Dept. of Physics, Berkeley.

ELECTRON-SPIN RESONANCE AND MAGNETIC SUSCEPTIBILITY MEASUREMENTS ON DILUTE ALLOYS OF Mn IN Cu, Ag, AND Mg, by J. Owen, M. E. Browne and others. [1957] [15]p. incl. diagrs. tables. (Technical rept. no. 87) (AFOSR-TN-57-723) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144434

Unclassified

Also published in Jour. Phys. Chem. Solids, v. 2: 85-99, Apr. 1957.

An account is given of some magnetic measurements made on alloys of Cu containing from 0.03 to 11 atomic per cent Mn in the temperature range 2° to 400°K. Less detailed work on Ag Mn and Mg Mn is also described. All of these alloys are found to obey a Curie-Weiss susceptibility law, and show an electron spin resonance line with free spin g-value. For most alloys the measured Curie constant suggests that there are between 4 and 5 unpaired electron spins per Mn atom. At low temperatures, alloys with more than about 1 atomic percent Mn appear to be antiferromagnetic, and show what can be interpreted as an unusual form of antiferromagnetic resonance absorption. Broadly speaking, the magnetic behavior is rather like that expected of Mn^{2+} ions coupled by strong short range interactions such as direct and superexchange. The expected long-range indirect exchange via conduction electrons appears to be extremely small, as has been previously pointed out by Owen, Browne, Knight and Kittel. (Contractor's abstract)

CAL.03:017 - CAL.03:020

CAL.03:017

California U. Dept. of Physics, Berkeley.

MAGNETIC PROPERTIES OF Cu-Mn ALLOYS, by K. Yosida. [1957] [6]p. incl. refs. (Technical rept. no. 88) (AFOSR-TN-57-724) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144435 Unclassified

Also published in Phys. Rev., v. 106: 893-898, June 1, 1957.

The polarization of conduction electrons due to s-d interaction in CuMn alloys is investigated. The uniform polarization due to the first order perturbed energy corresponding to the Fröhlich-Nabarro and Zener mechanism is shown to be completely modified by the first order perturbation of the wave functions and the polarization is concentrated in the neighborhood of the Mn ions. At the same time it is shown that the Fröhlich-Nabarro interaction is included in the Ruderman-Kittel result as one component. This point of view is corroborated by the experimental results on the electronic g-values of the Mn ions and the Knight shift of the Cu-nuclei which can be qualitatively accounted for by the Ruderman-Kittel mechanism. (Contractor's abstract, modified)

CAL.03:018

California U. Dept. of Physics, Berkeley.

THEORY OF CYCLOTRON RESONANCE IN METALS, by V. Heine. [1957] [24]p. incl. diagrs. refs. (Technical rept. no. 89) (AFOSR-TN-57-725) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144436 Unclassified

Also published in Phys. Rev., v. 107: 431-437, July 15, 1957.

Azbel' and Kaner have shown that a cyclotron resonance phenomenon is possible in a metal under extreme anomalous skin-effect conditions when the magnetic field is parallel to the metal surface. In this paper the correct form of the surface impedance is deduced in a more simple way by using the "ineffectiveness concept" of Pippard. An approximate criterion is also established for how nearly parallel to the surface the magnetic field must be. When the oscillating electric field is not parallel to the constant magnetic field, it produces a polarization of the charge distribution in the metal, and it is shown that this effect does not destroy the resonance in contrast to the situation in semiconductors. (Contractor's abstract)

CAL.03:019

California U. Dept. of Physics, Berkeley.

ANOMALOUS ELECTRICAL RESISTIVITY AND MAGNETORESISTANCE DUE TO AN s-d INTERACTION IN Cu-Mn ALLOYS, by K. Yosida. [1957] 23p. incl. tables, refs. (Technical rept. no. 90) (AFOSR-TN-57-726) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 144437 Unclassified

Also published in Phys. Rev., v. 107: 396-403, July 15, 1957.

The effect of the s-d exchange interaction between the conduction electrons and the Mn ions on the electrical behavior of Cu-Mn alloys is investigated from the molecular-field point of view. The magnitude of the anomalous resistivity calculated with the value of the exchange integral for a free Mn ion agrees with the experimental value within a factor of three. Also the temperature dependence of the resistivity obtained by the molecular-field approximation for the antiferromagnetic spin ordering is shown to be quite similar to the behavior exhibited by the alloys with more than 1 atomic percent Mn. For samples with lower concentration of Mn ions, however, the theoretical result shows only a monotonic decrease of the resistance below the Néel temperature. It shows neither the resistance minimum nor maximum which has been found experimentally for the very dilute alloys. The anomalous magnetoresistance calculated on the same basis is approximately proportional to the square of the magnetization and its magnitude is in good agreement with the experimental results, especially above the Néel temperature. The magnetoresistance of ferromagnetic metals is also discussed. (Contractor's abstract)

CAL.03:020

California U. Dept. of Physics, Berkeley.

EXCITON DOUBLET SPLITTING IN IONIC CRYSTALS, by R. Petersen. [1957] 3p. (Technical rept. no. 80) (AFOSR-TN-57-727) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr 22201], and Signal Corps) AD 144438 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 1: 284, Jan. 1957.

The origin of the exciton lines in alkali halide crystals has been previously attributed to an L-S coupling scheme. A mechanism involving the transfer of the excited electron from the anion to the nearest neighbor cations has been proposed. The similarity between rare gas atoms and halogens ions has lead to an estimate of the relative intensity of the two lines.

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CAL.03:021

California U. [Dept. of Physics] Berkeley.

EXPERIMENTAL EVIDENCE FOR ENERGY GAPS IN SUPERCONDUCTORS, by M. Tinkham. [1957] [6]p. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Published in Proc. Fifth Internat'l. Conf. on Low Temperature Phys. and Chem., Madison, Wis. (Aug. 26-31, 1957), Univ. of Wisconsin Press, Madison, 1958, p. 261-265.

A direct spectroscopic experiment is conducted to give evidence for energy gaps in superconductors. The power absorbed in creating excitations is measured as a function of photon energy. Therefore, the presence of an energy gap appears as an absence of absorption below a certain frequency. The data obtained together with specific heat data and recent data supporting a non-local theory appear to establish rather convincingly the existence of an energy gap in the electronic excitation spectrum of superconductors.

CAL.03:022

California U. Dept. of Physics, Berkeley.

EFFECTS OF THE PLASMA IN CYCLOTRON RESONANCE IN METALS AND SEMICONDUCTORS, by C. Kittel. [1957] [14]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) Unclassified

Also published in Proc. Conf. on Radio and Microwave Spectroscopy, Duke U., Durham, N. C. (Nov. 4-6, 1957), Washington, Office of Naval Research [1957] p. 81-85.

The question of the influence of plasma resonance on the cyclotron resonance in metals is discussed. A two-carrier model is introduced to investigate the possibility of observing the cyclotron resonance of one or both carriers, substantially unmodified by plasma effects due to the shorting out of plasma effects by means of the other carrier. The above has been shown to be possible as well as the cyclotron resonance in metals in which a portion of the carriers are non-resonant and act as effective second carriers. The derivation of the charge density decay relaxation time in metals is generalized to remove the discrepancy between the observed and calculated values.

CAL.03:023

California U. Dept. of Physics, Berkeley.

NUCLEAR SPECIFIC HEAT OF COBALT METAL (Abstract), by V. Arp, N. Kurti, and R. Petersen. [1957] [1]p. (AF 18(603)46) Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 388, Dec. 19, 1957.

The specific heat of a sample of cobalt metal has been measured in the temperature range 0.3 to 1.0°K and the contribution from nuclear polarization has been evaluated. An 8-gm polycrystalline sample was cooled in a conventional demagnetization cryostat. Measured amounts of heat were introduced via a manganin resistance wire wrapped around the sample, and temperature was measured by means of a calibrated carbon resistor. The results can be expressed

$$\frac{C}{R} \times 10^4 = \frac{6.2}{T} + 5.6 T$$

where the first term is the nuclear polarization contribution arising from h.f.a. coupling with the spin system, and the second is the usual conduction electron specific heat. The nuclear contribution appears to be in good agreement with a value deduced (by Grace et al, Bull. Amer. Phys. Soc., Series II, v. 2: 136, Dec. 1957) from anisotropy of γ -radiation emitted by polarized Co^{60} nuclei in a single crystal sample.

CAL.03:024

California U. Dept. of Physics, Berkeley.

IRREDUCIBLE REPRESENTATIONS OF THE FULL LORENTZ GROUP, by V. Heine. [1957] [4]p. incl. table. (Technical rept. no. 91) (AFOSR-TN-58-306) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, and Signal Corps) AD 215157 Unclassified

Also published in Phys. Rev., v. 107: 620-623, July 15, 1957.

The full Lorentz group consists of the group of ordinary Lorentz space-time transformations plus the space inversion, time inversion and space-time inversion transformations. The irreducible representations of the full Lorentz group and its subgroups are derived and tabulated for ease of reference and in order to correct an error which has appeared in the literature. The effect of complex conjugation of the base vectors of the representations has been investigated.

CAL.03:025 - CAL.03:028

CAL.03:025

California U. Dept. of Physics, Berkeley.

HYPERFINE STRUCTURE OF PARAMAGNETIC IONS, by V. Zeine. [1957] [2]p. (Technical rept. no. 92) (AFOSR-TN-58-307) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 215158
Unclassified

Also published in Phys. Rev., v. 107: 1002-1003, Aug. 15, 1957.

The hyperfine structure of several paramagnetic ions and atoms such as Mn^{++} is known to contain an unexpected and large contribution due to some admixture of unpaired s electrons in the wave function. An explanation of this is proposed in terms of the effect of exchange with the 3d electrons on the 2s and 3s electrons. Since the spins of the 3d electrons are at least partially lined up, exchange affects 2s, 3s electrons with parallel and antiparallel spin differently, so that the $2s^2 3s^2$ electrons are not exactly paired. A rough preliminary calculation gives sufficiently good agreement to suggest that the proposed mechanism is an important factor, if not the complete explanation. Some detailed differences between various ions remains puzzling. (Contractor's abstract)

CAL.03:026

California U. Dept. of Physics, Berkeley.

CONDUCTIVITY OF SUPERCONDUCTING FILMS FOR PHOTON ENERGIES BETWEEN 0.3 and $40 kT_c$, by R. E. Glover, III and M. Tinkham. [1957] [14]p. incl. diagrs. refs. (Technical rept. no. 93) (AFOSR-TN-58-308) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 215156
Unclassified

Also published in Phys. Rev., v. 108: 243-256, Oct. 15, 1957.

From transmission measurements for thin films of tin and lead, the frequency dependence ω of the complex conductivity $\sigma^*(\omega)$ has been determined for ω between $0.3\omega_c$ and $40\omega_c$, where $\omega_c = kT_c/\hbar$. The reduced frequency dependence $\sigma^*(\omega)/\sigma_{normal}$ expressed in terms of the reduced frequency ω/ω_c appears to be approximately universal and to be independent of the resistance, thickness, and degree of anneal of the films. At $T = 0$ the real part of σ^* appears to be zero for photon frequencies below $3\omega_c$ and it rises rapidly so that it reaches the limiting value σ_{normal} at about $20\omega_c$. Such behavior

suggests an energy gap of width about $3\hbar\omega_c$ in the electron excitation spectrum of the superconducting state. At $T = 0$ and $\omega < \omega_c$ the imaginary part σ_2 of σ^* is about $3.7\omega/\omega_c$. This $1/\omega$ dependence is in accord with the London theory but the London coefficient is about 100 times too large. Pippard's nonlocal modification of the London equations predicts a value of 6.7. For ω between $3\omega_c$ and $5\omega_c$, the value of σ_2 goes to zero as required by a term from the Kramers-Kronig relations. A temperature dependence has been obtained which is not in agreement with present theories.

CAL.03:027

California U. Dept. of Physics, Berkeley.

MAGNETORESISTANCE OF SINGLE CRYSTALS OF COPPER, by R. Olson and S. Rodriguez. Aug. 9, 1957, 7p. incl. diagrs. refs. (Technical rept. no. 94) (AFOSR-TN-58-309) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 215171
Unclassified

Also published in Phys. Rev., v. 108: 1212-1218, Dec. 1, 1957.

Measurements of the magnetoresistance coefficients at 4.2°K and at 20.4°K in single crystals of copper, silver, and gold in the low magnetic field range, and in single crystals of silver for high magnetic field are reported. The low-field results were analyzed under the assumptions that a relaxation time exists and is a function of the energy alone, and that the Fermi surface is a single closed surface within the first Brillouin zone and not touching its boundary. It is found that for copper the magnetoresistance cannot be fitted very well on this model. It is assumed that at low temperature the hypothesis that a relaxation time exists is a good approximation, and suggested that in copper the Fermi surface touches the boundary of the first Brillouin zone. The magnetoresistance of silver in high magnetic fields shows marked anisotropy and no sign of saturation. (Contractor's abstract)

CAL.03:028

California U. Dept. of Physics, Berkeley.

CYCLOTRON RESONANCE IN TIN, by A. F. Kip, D. N. Langenberg and others. [1957] [2]p. (Technical rept. no. 95) (AFOSR-TN-58-310) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 215159
Unclassified

Also published in Phys. Rev., v. 108: 494-495, Oct. 15, 1957.

CAL.03:029 - CAL.03:032

Cyclotron resonance has been observed in single crystals of tin at frequencies of 24 kMc/sec at 4°K. Subharmonic resonances have been observed which confirm the cyclotron resonance mechanism as the source of the microwave cavity losses. A linear dependence of H_c on the microwave frequency was observed and m^* found to be 0.2 to 3 m_e . The relaxation time was calculated to be 30×10^{-11} sec at 4°K and measured values up to 5 times this value observed leading to values of the mean free path of 1 millimeter.

CAL.03:029

California U. Dept. of Physics, Berkeley.

DORFMAN'S PROPOSAL REGARDING CYCLOTRON RESONANCE IN FERROMAGNETIC SUBSTANCES, by C. Kittel. [1957] [1]p. (Technical rept. no. 97) (AFOSR-TN-58-311) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 215160 Unclassified

Also published in Phys. Rev., v. 108: 1097-1098, Nov. 15, 1957.

The suggestion of Dorfman regarding the possibility of observing cyclotron resonance in ferromagnetic substances in the absence of an applied external magnetic field may be incorrect since the spin-orbit interaction in these substances is invariant under the translation group of the crystal. Other sources show that replacing the spin-orbit interaction by an effective magnetic field in the Hamiltonian will not describe the galvanometric and magneto-optical effects.

CAL.03:030

California U. Dept. of Physics, Berkeley.

THE BAND STRUCTURE OF ALUMINUM: A SELF-CONSISTENT CALCULATION, by R. E. Behringer. [1958] 2p. incl. tables. (Technical rept. no. 96) (AFOSR-TN-58-958) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 222414 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 5: 145-146, 1958.

The calculations reported in a paper by V. Heine (Proc. Roy. Soc., v. A240: 361, 1957) have been found to contain a systematic numerical error. The new results for the potential of a proton lattice are such as to raise the energy levels by 0.1 rydberg but to shift them relative to each other by only 0.03 rydberg. While this correction is quantitatively quite important, it does not change qualitatively the previous results.

CAL.03:031

California U. Dept. of Physics, Berkeley.

ON THE NUMBER OF 3d ELECTRONS IN IRON, by C. Kittel and W. Marshall. 1958, 1p. (Technical rept. no. 98) (AFOSR-TN-58-959) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 222521 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 6: 99, July 1958.

X-ray measurements on the atomic scattering factors of Cu, Ni, Co, Fe and Cr have been carried out by Weiss and De Marco (Internat'l. Conf. on Problems in Crystal Phys., Massachusetts Inst. of Tech., July 1-5, 1957) to determine the outer electron configuration in the metallic state. They quote the number of d-electrons in bcc iron to be 2.3 ± 0.3 electrons per atom. Microwave resonance and magneto-mechanical experiments yield values of the spectroscopic splitting factor $g > 2$ and magneto-mechanical ratio $g' \approx 2$. These results can be reconciled if there exist conduction states which are connected to the magnetic 3d wave-function states by means of spin-orbit perturbation.

CAL.03:032

California U. Dept. of Physics, Berkeley.

INTERACTION OF SPIN WAVES AND ULTRASONIC WAVES IN FERROMAGNETIC CRYSTALS, by C. Kittel. [1958] [6]p. (Technical rept. no. 102) (AFOSR-TN-58-960) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 222415 Unclassified

Also published in Phys. Rev., v. 110: 836-841, May 15, 1958.

A field-theoretical treatment is given of the magneto-elastic coupling of magnons and phonons in a ferromagnetic crystal. The effects of the coupling are large when the wavelengths and frequencies of the two fields are equal. If the two transverse phonon states of a given wave vector are degenerate, then the rotatory dispersion of the phonons will be large. The possibility exists of creating nonreciprocal acoustic elements, such as acoustic gyrators. At simultaneous resonance the phonon attenuation is expected to be large. The possibility of magnetostrictive transducers at microwave frequencies is discussed. A calculation is given of the damping by eddy currents of spin waves in a metal. (Contractor's abstract)

CAL.03:033 - CAL.03:036

CAL.03:033

California U. Dept. of Physics, Berkeley.

PENETRATION DEPTH, SUSCEPTIBILITY, AND NUCLEAR MAGNETIC RESONANCE IN FINELY DIVIDED SUPERCONDUCTORS, by M. Tinkham. [1958] [4]p. incl. diagr. refs. (Technical rept. no. 101) (AFOSR-TN-58-961) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 222416 Unclassified

Also published in Phys. Rev., v. 110: 26-28, Apr. 1, 1958.

The superconducting penetration depth λ is increased when the mean free path ℓ of the electrons in the sample is reduced by lattice disorder, impurities, or diffuse scattering at the sample boundary. This experimental evidence along with a simplification of Pippard's non-local theory is used to interpret the results of the experiments on small particles of superconducting substances. The formal results of London's theory can be taken over if London's λ_0 is modified to $\lambda_0 (1 + \xi_0/\ell_{\text{eff}})^{1/2}$, where ξ_0 is Pippard's coherence length and ℓ_{eff} includes both surface and body scattering. This method gives a good fit to Whitehead's susceptibility data on colloidal superconducting mercury, but predicts a narrower nuclear resonance line than is observed by Reif in a similar colloid.

CAL.03:034

California U. Dept. of Physics, Berkeley.

FAR INFRARED TRANSMISSION THROUGH METAL LIGHT PIPES, by R. C. Ohlmann, P. L. Richards, and M. Tinkham. [1958] [3]p. incl. diagr. (Technical rept. no. 103) (AFOSR-TN-58-962) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, National Security Agency, and National Science Foundation) AD 222417 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 48: 531-533, Aug. 1958.

The fractional transmission of far infrared radiation through metal light pipes is calculated and compared with experimental data. Transmission factors greater than fifty percent are obtained over distances of several feet with typical parameters. Condensing cones allow the output radiation to be concentrated onto a small detector area for spectroscopic applications. (Contractor's abstract)

CAL.03:035

California U. Dept. of Physics, Berkeley.

EXCITATION OF SPIN WAVES IN A FERROMAGNET BY A UNIFORM rf FIELD, by C. Kittel. [1958] [3]p. (Technical rept. no. 104) (AFOSR-TN-58-963) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 222418 Unclassified

Also published in Phys. Rev., v. 110: 1295-1297, June 15, 1958.

It is possible to excite exchange and magnetostatic spin waves in a ferromagnet by a uniform rf field, provided that spins on the surface of the specimen experience interactions different from those acting on spins in the interior. Modes with an odd number of half-wavelengths should be excited in a flat plate. The definition of what is meant by a different anisotropy interaction is worked out and is a rather lenient condition. Experiments which would determine the exchange energy constant should be possible using sufficiently thin platelets of single crystals having parallel faces. It is perhaps not unlikely that the theory may account for the observation by Waring and Jarrett of a large number of resonance peaks in NiMnO_3 . (Contractor's abstract)

CAL.03:036

California U. Dept. of Physics, Berkeley.

ORIENTATION OF NUCLEI IN FERROMAGNETS, by W. Marshall. [1958] [6]p. (Technical rept. no. 105) (AFOSR-TN-58-964) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 222419 Unclassified

Also published in Phys. Rev., v. 110: 1280-1285, June 15, 1958.

A theoretical discussion is given of the various orientation effects acting on nuclei in ferromagnets, and the results are compared to experimental measurements on the specific heat and the anisotropy in the emission of

γ rays by radioactive Co^{60} . The orientation is due to an effective magnetic field which is, neglecting some small terms, the sum of one negative and four positive contributions all of which are roughly comparable. The uncertainty in the total field predicted is considerable but nevertheless rough agreement is obtained with the few experimental results at present available. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

CAL.03:037 - CAL.03:041

CAL.03:037

California U. Dept. of Physics, Berkeley.

SUPERCONDUCTING ENERGY GAP INFERENCES FROM THIN-FILM TRANSMISSION DATA, by M. Tinkham and R. E. Glover, III. [1958] [2]p. incl. diagr. refs. (Technical rept. no. 106) (AFOSR-TN-58-965) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, National Security Agency, and National Science Foundation) AD 222420
Unclassified

Also published in Phys. Rev., v. 110: 778-779, May 1, 1958.

The gap in the density of electron states in superconducting materials has been found to have a width of $3-4\omega_c$ and have a dependence such that (real part $\sigma^*/\sigma_{\text{normal}} = 1 - (\omega_c/\omega)^{1.65}$, where $\omega_c = kT_c/\hbar$. This conclusion follows both from plots of $\sigma_{\text{normal}}/(\sigma_{\text{normal}} - \text{real part } \sigma(\omega))$ vs ω/ω_c and also from a theoretical model which has a humping up of states displaced from the gap to either side.

CAL.03:038

California U. Dept. of Physics, Berkeley.

PARAMAGNETIC SUSCEPTIBILITY IN SUPERCONDUCTORS, by K. Yosida. [1958] [2]p. incl. diagr. (Technical rept. no. 107) (AFOSR-TN-58-966) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, Signal Corps, and National Security Agency) AD 222519
Unclassified

Also published in Phys. Rev., v. 110: 769-770, May 1, 1958.

The temperature dependence of the paramagnetic susceptibility χ has been calculated on the basis of the Bardeen, Cooper, and Schrieffer theory of superconductivity, and compared with the data obtained by Reif (Phys. Rev., v. 106: 208, 1957) and Knight et al (Phys. Rev., v. 104: 852, 1956). The data presented by Reif requires that χ have a non-zero component at zero temperature. This is in disagreement with the theory presented but the single experimental value quoted by Knight is in rough agreement with the theory.

CAL.03:039

California U. Dept. of Physics, Berkeley.

PARAMAGNETIC CENTERS AS DETECTORS OF ULTRASONIC RADIATION AT MICROWAVE FREQUENCIES, by C. Kittel. [1958] [4]p. (Sponsored jointly by

Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency)

Unclassified

Also published in Phys. Rev. Letters, v. 1: 5-6, July 1, 1958.

There are a number of suitable transducers that should produce microwave phonons, and it is suggested that these phonons could be detected by the change in saturation of an electron-spin resonance-line that they cause. The detector would be operated near saturation of the line in a paramagnetic salt with the external magnetic field adjusted so that paramagnetic resonance occurs at the phonon frequency. An approximate calculation shows that a sensitivity of $10^{-4} \mu\text{W}/\text{cm}^3$ of phonon energy flux is possible.

CAL.03:040

California U. Dept. of Physics, Berkeley.

REMARKS ON THE THEORY OF SUPERCONDUCTIVITY, by K. Yosida. [1958] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Published in Phys. Rev., v. 111: 1255-1256, Sept. 1, 1958.

The relation between the Bardeen-Copper-Schrieffer theory and the Bogoliubov theory of superconductivity is discussed. It is shown that the B-C-S trial wave function is derived by the same transformation as that used by Bogoliubov, and that the integral equation which determines an introduced parameter is equivalent. Some remarks are also made on the excited-state wave functions. (Contractor's abstract)

CAL.03:041

California U. Dept. of Physics, Berkeley.

ABSORPTION OF ELECTROMAGNETIC RADIATION IN SUPERCONDUCTORS, by M. Tinkham. [1958] [13]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, Office of Naval Research under Nonr-22201, National Science Foundation, and National Security Agency) Unclassified

Presented at Karslingh Onnes Conf. on Low Temperature Physics, Leyden (Netherlands), June 23-28, 1958.

Published in Physica, Suppl., v. 24: S35-S41, Sept. 1958.

CAL.03:042 - CAL.03:045

An energy gap of 4-4.5 kT_c has been measured for superconducting lead by means of a multiple reflection technique in a lead cavity. This value is in basic agreement with the extrapolated data on thin films but does not agree with the value 3.5 kT_c predicted by the BCS theory or the expected value from the specific heat data of other metals. This possibly indicates that lead does not satisfy the law of corresponding states or that there exists a selection rule inhibiting transitions to states at the edge of the gap.

CAL.03:042

California U. Dept. of Physics, Berkeley.

NUMBER OF SINGLE, DOUBLE, AND TRIPLE CLUSTERS IN A SYSTEM CONTAINING TWO TYPES OF ATOMS, by R. E. Behringer. [1958] [3]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Published in Jour. Chem. Phys., v. 29: 537-539, Sept. 1958.

A set of graphs are presented from which one can read directly the probability that, in a lattice containing two types of atoms A and B randomly distributed over the lattice sites, a type A atom will be in a cluster of one, two, or three A atoms. Results are presented as a function of concentration for simple cubic, body-centered cubic, face-centered cubic, and hexagonal close-packed lattices. (Contractor's abstract)

CAL.03:043

California U. Dept. of Physics, Berkeley.

MAGNETIC FIELD DEPENDENCE OF ULTRASONIC ATTENUATION IN METALS AT LOW TEMPERATURES, by S. Rodriguez. [1958] 30p. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Also published in Phys. Rev., v. 112: 80-89, Oct. 1, 1958.

A theory of the effect of a constant magnetic field on the behavior of ultrasonic attenuation in normal metals at low temperatures of the order of liquid helium temperatures is given. The ideas are of the same kind as those suggested by Pippard to account for the attenuation in the absence of an external field. The different geometries are specified by the directions of three vectors, the wave vector q of the acoustic wave, the direction of polarization u_0 , and the external magnetic field

H_0 . The analysis shows that, for a transverse wave polarized in the direction of H_0 (i.e., u_0 are parallel and both are perpendicular to q) the attenuation decreases as $|H_0|^{-2}$ are large fields. When u_0 and H_0 are perpendicular and q is perpendicular to both, the attenuation increases as $|H_0|^{-2}$ for large $|H_0|$. For a wave such that u_0 and q are parallel and H_0 is perpendicular to q , the attenuation increases asymptotically to a constant value as $|H_0|$ increases. The maxima and minima obtained experimentally by Morse and co-workers cannot be explained on this model. An absorption similar to that occurring in cyclotron resonance absorption is obtained in the attenuation of transverse waves (u_0 perpendicular to q) when H_0 is parallel to q . (Contractor's abstract)

CAL.03:044

California U. Dept. of Physics, Berkeley.

THE LINEAR ANTIFERROMAGNETIC CHAIN WITH ANISOTROPIC COUPLING, by R. Orbach. [1958] 27p. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Published in Phys. Rev., v. 112: 309-316, Oct. 15, 1958.

The exact solution is given for a linear chain of N atoms of spin $\frac{1}{2}$ coupled together by the anisotropic Hamiltonian

$$H = 2J \sum_{l=1}^N [S_l^x S_{l+1}^x + (1-\alpha)(S_l^x S_{l+1}^y + S_l^y S_{l+1}^y)].$$

The energy of the antiferromagnetic ground state is computed and comparison is made with a variational method. The parameter α is allowed to vary between 0 and 1, regulating the relative amount of using anisotropy. The short-range order, $\sum_l S_l^x S_{l+1}^x$, is calculated exactly from the variation of the ground-state energy with α . It is shown that a kink in the short-range order curve calculated using the variational method is fictitious, and the associated discontinuity in $\partial^2 E / \partial \alpha^2$ is nonexistent. A discussion is given of long-range order and criticisms are presented regarding the predictions of the variational method. (Contractor's abstract)

CAL.03:045

California U. Dept. of Physics, Berkeley.

MAGNETIC ANISOTROPIC CONSTANT OF YTTRIUM IRON GARNET AT 0°K, by B. R. Cooper. [1958] [2]p.

CAL.03:046 - CAL.03:048

(Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Published in Phys. Rev., v. 112: 395-396, Oct. 15, 1953.

The anisotropy energy of yttrium iron garnet is separated into two parts, the normal part predominant at high temperatures, and the anomalous part important below 50°K. By comparison with ferrite data, the cause of the normal anisotropy is expected to be the coupling of the Fe^{3+} ions to the crystalline field. The following expression for K_1 , the first-order anisotropy constant, as a function of the fine structure coupling constants a_{24} (tetrahedral sites) and a_{16} (octahedral sites) is obtained: $K_1/\text{unit cell} = -46.6a_{24} - 13.6a_{16}$.

CAL.03:046

California U. Dept. of Physics, Berkeley.

ANTIFERROMAGNETIC MAGNON DISPERSION LAW AND BLOCH WALL ENERGIES IN FERROMAGNETS AND ANTIFERROMAGNETS, by R. Orbach. [1958] 18p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Presented at Magnetism Conference, Philadelphia, Pa., Nov. 1958.

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 400, Dec. 29, 1958.

Also published in Phys. Rev., v. 115: 1181-1184, Sept. 1, 1959.

The exact eigenstates of the exchange Hamiltonian are found for short chains of 4, 6, 8, and 10 atoms of spin $\frac{1}{2}$. A linear dispersion law for magnons in an antiferromagnet is exhibited by the energy spectrum. Rotation operators are applied to the exact ferromagnetic and antiferromagnetic ground states to give semiclassical states simulating 360° Bloch walls. These states are projected upon the exact eigenvectors of the exchange Hamiltonian. The wall energies are computed, and it is shown that the $S = 0$ and $S = 1$ states are most important. The periodic boundary conditions are then removed, and the ends of the chain held fixed, both parallel or antiparallel. The energy of the 180° Bloch wall is computed and compared with the classical result. It is found that the semiclassical ferromagnetic wall is a good approximation to the exact wall. The energy of the semiclassical antiferromagnetic wall is not a very good approxima-

tion to the exact wall energy, but the semiclassical energy appears to have the correct dependence on the wall thickness. (Contractor's abstract)

CAL.03:047

California U. Dept. of Physics, Berkeley.

A NOTE ON THE THEORY OF CYCLOTRON RESONANCE IN METALS, by S. Rodriguez. [1958] 14p. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Also published in Phys. Rev., v. 112: 1616-1620, Dec. 1, 1958.

The surface impedance of a metal, in the extreme anomalous skin effect region and in the presence of a magnetic field H_0 parallel to its surface, is calculated assuming specular reflection and spherical energy bands. The surface impedance is given in the cases in which the microwave electric field is parallel and at right angles with H_0 , which is called longitudinal and transverse, respectively. The position, intensities, and width of the cyclotron resonance lines are the same for longitudinal and transverse cyclotron resonance. (Contractor's abstract)

CAL.03:048

California U. Dept. of Physics, Berkeley.

CONDUCTIVITY IN PbS FILMS FROM dc TO 10 kmc/s (Abstract), by D. P. Snowden, A. M. Portis, and R. F. Brebrick. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Presented at meeting of the Amer. Phys. Soc., Calif. U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 410, Dec. 29, 1958.

Measurements of conductivity and photoconductivity as a function of frequency from dc to 10 kmc/sec have been made on chemically deposited lead sulfide films. In addition, the mobility of dark and photocarriers has been determined at dc by measurement of the Hall effect and at 10 kmc/sec by microwave Faraday rotation. The electrode design used for the rf measurements avoids the apparent increase in conductivity which has been analyzed by Lax and Sachs as a self-capacitance effect. The increase in conductivity observed in the present experiments is believed to be characteristic of the electrical structure of the sample. All samples exhibit a con-

CAL.03:049 - CAL.03:051

ductivity which is relatively insensitive to frequency up to about 100 mc/sec. Within a decade of this frequency the conductivity increases by nearly an order of magnitude and then remains constant again into microwave region. The photoconductivity on the other hand is essentially constant over the entire frequency range with a broad hump in the 100-mc/sec range. These results lend support to a model for PbS films consisting of alternate n-type and p-type regions, provided that the contribution of minority as well as majority carriers in both regions is considered.

CAL.03:049

California U. [Dept. of Physics] Berkeley.

DOMAIN WALL DYNAMICS IN THE SUPERCONDUCTING INTERMEDIATE STATE (Abstract), by D. Feldman and R. C. La Force. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-60346], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency)

Unclassified

Presented at meeting of the Amer. Phys. Soc., Calif. U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 400, Dec. 29, 1958.

The authors have investigated the dynamics of domain wall motion in the superconducting intermediate state for lead and tin samples in the form of either rods, diameter 140 μ , or small particles, diameter 1-10 μ . The susceptibility, χ , of the samples was measured as a function of applied magnetic field, H, by placing the sample in an rf oscillator tank coil and observing the frequency shift vs H. The same arrangement was used to determine $d\chi/dH$, but in the case 0.1 to 1% of the applied magnetic field was modulated at a frequency f between 10 cps and 50 kc in order to produce the derivative. The $d\chi/dH$ vs H curve has a maximum value where χ vs H has maximum slope. However, hysteresis effects are observed in $d\chi/dH$ vs H which are not observed in χ vs H. Moreover, a second maximum in $d\chi/dH$ for lead is observed above the critical field. The amplitude of the maximum in the $d\chi/dH$ vs H curve below the critical field is a function of modulation frequency, f, and is proportional to $1/f$ for large f. This later behavior is understandable on the basis of a theory of eddy current damped domain wall motion.

CAL.03:050

California U. [Dept. of Physics] Berkeley.

OBSERVATION OF CYCLOTRON RESONANCE IN COPPER (Abstract), by D. N. Langenberg, A. F. Kip, and B. Rosenblum. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)-46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency)

Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 416, Dec. 29, 1958.

An Azbel-Kaner type cyclotron resonance has been observed in a sample of natural copper. Fundamental and subharmonic resonance minima of order $q = 1, 2, 3, 4$ were observed superimposed on a monotonically decreasing surface resistance with a form qualitatively like $R(H) = R(0) \tanh^{1/3} A/H$. The resonance was observed only near particular sample orientations, and in the region of observability the cyclotron mass was essentially independent of orientation. The agreement between the experimental resonance curve and a theoretical curve calculated using $\omega\tau = 10$ is satisfactory and gives a cyclotron mass $m^*/m_e = 1.37 \pm 0.05$. This mass is consistent with estimates of extremal cyclotron masses calculated from Moliner's analytical expression for Pippard's Fermi surface. No phase shift between experimental and theoretical curves like that reported by Aubrey and Chambers is present.

CAL.03:051

California U. [Dept. of Physics] Berkeley.

OBSERVATION OF MICROWAVE FARADAY ROTATION IN MnF_2 (Abstract), by D. Teaney and A. M. Portis.

[1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency)

Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 416, Dec. 29, 1958.

Microwave Faraday rotation has been observed in MnF_2 between 25°K and 300°K. The most striking characteristic of the data is the increase in the rotation by nearly three orders of magnitude as the temperature of the sample is raised above the Néel point. The measurements were made on a single crystal of MnF_2 cemented to the end wall of a bimodal transmission cavity. The detection of antiferromagnetic Faraday rotation is made possible by the exceptional stability of the bimodal cavity. The sample was oriented so that the c axis of the sample coincided with the symmetry axis of the cavity. The filling factor of the sample in the cavity was determined from rotation measurements in the paramagnetic range. From this information and an analysis of the response of the bimodal cavity values of the off-diagonal elements of the susceptibility tensor are obtained as a function of temperature.

CAL. 03:052-054; CAL. 11:001

CAL.03:052

California U. [Dept. of Physics] Berkeley.

THEORY OF MICROWAVE FARADAY ROTATION IN MnF_2 (Abstract), by A. M. Portis. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 416, Dec. 29, 1958.

Microwave Faraday rotation in antiferromagnetics was predicted theoretically by Wangness, who obtained an expression for the rotation to be expected at $T = 0^\circ K$. The authors extended this treatment to higher temperatures and compared the results with experiment. An equation of motion was used which below the transition had the form introduced by Kittel. Above the transition the equations assumed the familiar Bloch form. Below the transition in the limit of small fields and at frequencies well below the antiferromagnetic resonance frequency it was found that the off-diagonal element of the susceptibility tensor,

$$\chi_{xy} = 2i\omega\gamma H_0 (\chi_{\perp} - \chi_{\parallel}) / \omega_0^2, \text{ where } \omega_0 \text{ is the zero-field}$$

antiferromagnetic resonance frequency. There was generally good agreement between experiment and the predicted curves except in the immediate vicinity of the transition. In particular, the decrease in rotation by three orders of magnitude, which is expected as the material becomes antiferromagnetic, took place over a 10° range of temperature. It did not appear that the temperature dependence in this range could be understood in terms of a simple resonance equation but requires an investigation of the spectrum of excited states.

CAL.03:053

California U. Dept. of Physics, Berkeley.

MICROWAVE FARADAY ROTATION: DESIGN AND ANALYSIS OF A BIMODAL CAVITY, by A. M. Portis and D. Teaney. [1958] [7]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Published in Jour. Appl. Phys., v. 29: 1692-1698, Dec. 1958.

The design and analysis of a bimodal cavity for the observation of microwave Faraday rotation is presented. An equivalent circuit of lumped elements is developed

and the coupling between degenerate cavity modes is expressed in terms of elements of the susceptibility tensor of the material producing the rotation. The theory is checked against experimental results with a paramagnetic salt and substantial agreement is obtained. A cavity of this type when used in conjunction with superheterodyne detection appears to provide a high sensitivity spectrometer for the observation of magnetic resonance. (Contractor's abstract)

CAL.03:054

California U. Dept. of Physics, Berkeley.

EXCITATION OF SPIN WAVES IN AN ANTIFERROMAGNET BY A UNIFORM rf FIELD, by R. Orbach and P. Pincus. [1958] 10p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], Office of Naval Research under [Nonr-22201], Signal Corps, and National Security Agency) Unclassified

Also published in Phys. Rev., v. 113: 1213-1215, Mar. 1, 1959.

It is possible to excite exchange and magnetostatic spin waves in an antiferromagnet by a uniform rf field, provided that spins on the surface of the specimen experience anisotropy interactions different from those acting on the spins in the interior. Modes with an odd number of half-wavelengths should be excited in a flat plate. The condition for different anisotropy interactions is worked out and proves to be a lenient condition. Experiments which would determine the exchange energy constant and the anisotropy field should be possible using sufficiently thin platelets of single crystals having parallel faces. (Contractor's abstract)

CAL.11:001

California U. Dept. of Physics, Berkeley.

ON THE BOUND STATE PROBLEM IN QUANTUM FIELD THEORY, by W. Zimmerman. [1958] [24]p. incl. refs. (AFOSR-TN-58-764) (AF 49(638)327) AD 201863 Unclassified

Also published in Nuovo Cimento, Series X, v. 10: 597-614, Nov. 18, 1958.

A causal and invariant scalar field involving a stable bound state is investigated. A formula for the S-matrix is derived and it is shown that the bound state can be described by a local and invariant field operator. For simplicity only the case of spin zero particles and bound states is considered; however, the extension to other cases is possible. (Contractor's abstract)

CAL. 11:002; CAL. 12:001; CAL. 04:005, 006

CAL. 11:002

California U. [Dept. of Physics] Berkeley.

RADIATIVE CAPTURE OF ORBITAL K^- MESONS BY NUCLEI (Abstract), by G. Frye. [1958] [1]p. [AF 49-(638)327] Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 402, Dec. 29, 1958.

A discussion is presented of the radiative transition of K^- mesons in atomic orbitals from a state (n, l) to a state $(n', l - 1)$ on the assumption that nuclear capture is much more likely from the latter state. The x-radiation may occur together with the orbital K^- -meson capture as part of a two-step process. Then the energy released by the capture is shared with the proton, giving it a continuous spectrum with typical resonance peaks corresponding to the usual x-ray lines. The theory for radiative capture of K^- electrons is applied in detail to this problem. The photon spectrum and the total transition probabilities for radiative capture from $l = 1, 2, 3 \dots$ states are estimated. In radiative capture from the $2P$ state, for instance, two percent of the photons have an energy greater than twice the $1S$ -state binding energy.

CAL. 12:001

California U. Dept. of Physics, Berkeley.

NUCLEAR SPIN, HYPERFINE-STRUCTURE SEPARATION AND MAGNETIC MOMENT OF POTASSIUM-43 (Abstract), by F. R. Petersen, F. J. Ehlers and others. [1958] [1]p. [AF 49(638)339] Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 415, Dec. 29, 1958.

With the atomic beam magnetic resonance technique the nuclear spin of ^{43}K has been measured as $3/2$. The isotope is collected on a sulfur coated surface and beta counted in continuous flow proportional counters. An initial search was conducted on the usual flop-in transition ($F = 2, M_F = -1 \rightarrow -2$) at low magnetic fields.

At higher values of the field the quadratic shift of frequency of this line yields a sufficiently good value of the hyperfine structure constant to permit a search for direct transitions between the $F = 2$ and $F = 1$ levels. Of the 6 observable transitions of the $\Delta F = 1$ type the $M_F = 0 \rightarrow 0, 1 \rightarrow 0$ doublet, and the $-1 \rightarrow 0$ doublet transitions have been observed. A preliminary hyperfine

structure separation of $192.6 \pm .2$ mc/sec for the $^2S_{1/2}$ electronic ground state is obtained. Through use of the Fermi-Segrè formula and K^{39} as a reference isotope the magnetic moment becomes $\mu_K = \pm .163 \pm .002$ n.m. The radioisotope was prepared by $A^{40}(\alpha, p)K^{43}$ reactions with 20 mev alpha particles from the Berkeley 60" cyclotron. The alpha energy is initially degraded from 47 mev to reduce the production of K^{42} through the α, pn reaction. Stable potassium serves as carrier for the radioisotope and is used to calibrate the homogeneous C-field.

CAL. 04:005

California U. Electronics Research Lab., Berkeley.

TIME DOMAIN SYNTHESIS OF SAMPLED-DATA CONTROL SYSTEMS, by E. I. Jury and F. W. Semelka. Feb. 1957, 32p. illus. diagrs. (AFOSR-TN-57-58) (AF 18(600)1521) AD 115098 Unclassified

Also published in Trans. Amer. Soc. Mech. Engineers, v. 80: 1827-1839, Nov. 1958.

The application of the modified z-transform to synthesis of sampled-data control systems is discussed. The applicability of the modified z-transform as an analysis tool has been demonstrated in recent publications. At present, this transform method is being developed to reduce the process of synthesis of both sampled-data and continuous systems to systematic, straightforward numerical processes. The synthesis procedure presented is a time domain technique which permits the designer to achieve control of the continuous behavior of the system. The desired characteristics are specified in terms of standard synthesis criteria, and from such specifications the required compensation transfer functions are determined. An example illustrates the procedure and an analog computer study shows the nature of the effects realized by this approximation technique.

CAL. 04:006

California U. Electronics Research Lab., Berkeley.

APPLICATION OF THE p-TRANSFORM METHOD TO ANALYSIS OF MULTIPLE SAMPLER SYSTEMS (OPEN LOOP), by G. Farmanfarma. Jan. 9, 1957, 42p. incl. diagrs. tables. (Series no. 60; issue no. 174) (AFOSR-TN-57-76) (AF 18(600)1521) AD 120419 Unclassified

The p-transform method has been extended to the analysis of multiple sampler open loop systems. The technique outlined is general, no restrictions being imposed on the number or the periodicity of the samplers present. It is shown that by a combination of a few fundamental steps, it is possible to treat any open loop multiple sampler

CAL.04:007 - CAL.04:009

system. These steps have been outlined and simple examples given to demonstrate their applications.

CAL.04:007

California U. Electronics Research Lab., Berkeley.

ANALYSIS OF MULTIPLE SAMPLER SYSTEMS WITH FINITE PULSE WIDTH, OPEN LOOP [PART II], by G. Farmanfarma. [1957] [9]p. incl. diagrs. table. (AFOSR-TN-57-532) (AF 18(600)1521) AD 136513

Unclassified

Also published in Trans. Amer. Inst. Elec. Engineers, v. 77 (Part II): 20-28, Mar. 1958.

The Laplace transform method has been applied to the analysis of multiple-sampler systems. The method of analysis is based on a contour integral, which is derived from the Laplace transformation, and which mathematically describes the operation of a sampler with finite pulse width. This contour integral referred to as p-transformation in references is employed for the exact analysis of linear multiple-sampler open-loop systems with finite pulse width. It is shown that by a combination of a few fundamental steps it is possible to treat any open-loop system. These steps have been outlined and simple examples given to demonstrate their application. The technique is general, no restriction being imposed on the number or the periodicity of samplers present. It may be applied to systems with delayed samplers, and periodic samplers with different periods and pulse widths, as well as to systems which include nonperiodic samplers both with respect to period and/or pulse width. In each case the solution is exact and in systems with periodic samplers it can always be expressed in a closed form. The limiting cases are also considered. As a consequence of these, a method is obtained for analysis of open-loop sample-data systems with zero pulse width which include two or more samplers. (Contractor's abstract)

CAL.04:008

California U. Electronics Research Lab., Berkeley.

GENERAL ANALYSIS AND STABILITY STUDY OF FINITE PULSED FEEDBACK SYSTEMS, by G. Farmanfarma. Nov. 20, 1957, 74p. incl. diagrs. tables, refs. (Series no. 60; issue no. 196) (AFOSR-TN-57-608) (AF 18(600)1521) AD 136598

Unclassified

Also published in Trans. Amer. Inst. Elec. Engineers, v. 77 (Part II): 148-162, July 1958.

A method is presented for the analysis of finite pulsed feedback systems. The pulse width and the pulse shape are considered in its analytical treatment. The technique is based on the superposition principle, as well as some operational properties of the Laplace transform.

The application of this method to systems with periodic samplers leads to a set of simultaneous first order difference equations with constant coefficients. The stability conditions are independent of the input but are functions of the pole-zero configurations of both the open and closed loop transfer functions, as well as the sampler characteristics. The plotted responses of an error pulsed second order system to a step, ramp, and a sinusoidal input function indicate that, in each case, as the pulse width h approaches the sampler period the output approaches the equivalent continuous system response. It can be shown that as $h \rightarrow 0$ and the gain of the system is increased inversely as h , the output corresponds to the equivalent sampled-data system. (Contractor's abstract)

CAL.04:009

California U. Electronics Research Lab., Berkeley.

ADDITIONS TO THE MODIFIED z-TRANSFORM METHOD, by E. I. Jury. [1957] [21]p. incl. diagrs. tables, refs. [AF 18(600)1521]

Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 20-23, 1957.

Published in I.R.E. WESCON Convention Record, Pt. 4: 136-156, 1957.

The theory of the modified z-transform is further developed and extended. It is shown that the modified z-transform is a general method that can be systematically applied for the exact analysis of sampled-data control systems or any system that can be described by mixed linear difference-differential equations. The z-transform method is shown to be a special case which can be obtained from the modified z-transform. Tables of various sampled-data systems configuration have been developed which indicates the transfer function of such configurations. Extensive tables of the modified z-transform are introduced which aid considerably in the analysis and synthesis of sampled-data systems. Theorems relating to inverse modified z-transform, initial and final value theorems, differentiation, translation, limiting value, integration, maxima and minima, mean square value are introduced. Stability considerations and hidden oscillations are discussed and the limitations of the z-transform method are indicated. Properties of the modified z-transform transfer function are enumerated which aid in the design of sampled-data system. The modified z-transform method has been applied to the analysis of sampled-data systems with pure delay. Cases of delays which are integer and non-integer values of the sampling period are considered. It is also shown that the modified z-transform can be applied to obtain the inverse Laplace transform of certain functions in a closed form and a short table is introduced to show the equivalence of an infinite series.

CAL.04:010 - CAL.04:013

CAL.04:010

California U. Electronics Research Lab., Berkeley.

A NOTE ON THE OPERATIONAL SOLUTION OF LINEAR DIFFERENCE EQUATIONS, by F. J. Mullin and E. I. Jury. Mar. 14, 1958 [20]p. incl. diagrs. refs. (Series no. 60, issue no. 199) (AFOSR-TN-58-100) (AF 18(600)1521) AD 148149 Unclassified

Also published in Jour. Franklin Inst., v. 266: 189-205, Sept. 1958.

The z-transform is applied to the solution of linear difference equations with constant coefficients; boundary conditions are considered in the resulting solutions, and certain theorems related to the z-transform are applied to obtain qualitative information about the solution. The z-transform is used to solve simultaneous difference equations with constant coefficients and the modified z-transform is used to solve difference equations whose coefficients are periodic functions. Finally the z-transform is applied to the solution of difference equations with periodic coefficients. The methods of solution are illustrated with various examples which indicate the straightforward procedure for applying the z-transform and the modified z-transform to the solution of difference equations. (Contractor's abstract)

CAL.04:011

California U. Electronics Research Lab., Berkeley.

CONTRIBUTION TO STATISTICAL DESIGNING OF SAMPLED-DATA CONTROL SYSTEM, by T. Nishimura and E. I. Jury. Aug. 5, 1958 [158]p. incl. diagrs. refs. (Series no. 60; issue no. 210) (AFOSR-TN-58-613) (AF 18(600)1521) AD 162141; PB 140677

Unclassified

The derivation of the optimum discrete compensator is presented for the continuous-discrete sampled-data control system by means of the modified z-transform. An expression for the discrete power spectral density is introduced in order to solve the complicated problem of the continuous-discrete systems. The idea of the modified z-transform with a fictitious advance is adopted in order to keep the symmetry with the modified z-transform in the ordinary sense. The meaning of the modified z-transform of the power spectral density is explained. The general optimization procedures are demonstrated for the ordinary feedback system with a discrete compensator in the forward path, the feedback system with a pure delay in it, and the feedback system with a discrete compensator in the feedback path. The power spectral densities in the system with finite pulse width, as well as the multiple, and mixed sampling systems are derived. (Contractor's abstract)

CAL.04:012

California U. Electronics Research Lab., Berkeley.

THE ANALYSIS OF SAMPLED-DATA CONTROL SYSTEMS WITH A PERIODICALLY TIME VARYING SAMPLING RATE, by F. J. Mullin and E. I. Jury. June 30, 1958 [24]p. incl. diagrs. refs. (Series no. 60, issue no. 207) (AFOSR-TN-58-665) (AF 18(600)1521) AD 162196 Unclassified

Also published in I.R.E. Trans. of Professional Group on Automatic Control, v. AC-4: 15-21, May 1959.

The z-transform is used to solve sampled-data feedback systems which have a periodically time varying sampling rate. Such systems are described by linear difference equations with periodic coefficients; however the difference equation which describes the system at the sampling instants corresponding to KN , where N is the period of the coefficients and $K = 0, 1, 2, \dots$ is a linear difference equation with constant coefficients. Thus, by forming a series of constant coefficient difference equations which individually describe the system at sampling instants corresponding to $n = KN, KN + 1, KN + 2, \dots, (K+1)N-1$, the time varying features of the system are in essence removed from the analysis. The z-transform can then be used to solve the resulting constant coefficient difference equations. The response between sampling instants can also be obtained from the solution of the difference equations. The method presented is straightforward and can be used to analyze any linear sampled-data system which has a periodic sampling rate. It can also be used in problems of inventory control, production control and in the operation research field. Furthermore it can be used in approximating a continuous control system by a sampled system which contains a periodically time varying sampling rate to obtain a better approximation than is possible with a fixed sampling rate. In this method the only periodicity of the sampling rate is assumed and no relationship between the individual sampling intervals is required. A few examples were introduced for analysis purposes and the features of the response of such a system to sinusoidal inputs is indicated in one of the examples. (Contractor's abstract)

CAL.04:013

California U. Electronics Research Lab., Berkeley.

ANALYSIS OF INTEGRAL-SQUARE ERROR IN SAMPLED-DATA CONTROL SYSTEMS, by B. H. Bharucha. June 30, 1958, 48p. incl. diagrs. tables, refs. (Series no. 60; issue no. 206) (AFOSR-TN-58-679) (AF 18(600)1521) AD 162211; PB 137786 Unclassified

Finite moments of the squared error of a linear time-invariant (continuous or sampled-data) control system for a non-random input are developed as integrals in the modified z-transform domain. An explicit solution of the zero moment of the total squared error integral is

CAL. 04:014-016; A CAL. 04:014-016;
CAL. 13:001

given as the ratio of determinants of $2n \times n$ matrices where n is the order of the system characteristic polynomial in z . The elements of the matrices are obtained readily from the coefficients of the rational form in z of the modified z -transform of the error signal. The integral-square (total squared) error is now an explicit function of the free parameters of the system and can be studied to realize an appropriate minimization. A short table of solutions of the total squared error integrals is given. (Contractor's abstract)

CAL.04:014

California U. Electronics Research Lab., Berkeley.

INPUT-OUTPUT RELATIONSHIPS OF MULTI-SAMPLED-LOOP SYSTEMS, by G. G. Lendaris and E. I. Jury. Dec. 3, 1958 [36]p. incl. diagrs. table, refs. (Series no. 60; issue no. 214) (AFOSR-TN-58-813) (AF 18(600)1521) AD 202358; PB 138741

Unclassified

Also published in Trans. Amer. Inst. Elec. Engineers, v. 78 (Part II): 375-385, Jan. 1960.

A general gain expression for a multi-sampled-loop, sampled-data system is proposed, and an extended table of systems to which this gain expression applied is presented. (Contractor's abstract)

CAL.04:015

California U. Electronics Research Lab., Berkeley.

THE ANALYSIS AND COMPENSATION OF NONLINEAR SAMPLED-DATA FEEDBACK SYSTEMS, by F. J. Mullin. Aug. 22, 1958, [122]p. incl. diagrs. refs. (Series no. 60; issue no. 211) (AFOSR-TN-58-825) (AF 18(600)1521) AD 202910

Unclassified

Two types of sampled-data nonlinearities are investigated: relay sampled-data systems and sampled-data systems which have a saturating amplifier. In the study of relay sampled-data systems a method for determining the exact, continuous response of these systems using the phase plane is developed. This method of analysis is restricted to second and third order systems, but no restrictions are placed on the form of the input to these systems. The relay may be ideal or it may have a dead zone, and the effect of the width of the dead zone on the response of the system is discussed. As a by-product of this study, the limitations of the describing function as a method of analysis becomes clear. For saturating sampled-data systems the necessary and sufficient condition under which these systems are stable is developed, the stability conditions are investigated, and a method for obtaining an approximate numerical solution for the sampled error signal is presented. Finally, a method of compensating

saturated sampled-data systems is discussed. (Contractor's abstract)

CAL.04:016

California U. Electronics Research Lab., Berkeley.

A PHASE-PLANE APPROACH TO RELAY SAMPLED-DATA FEEDBACK SYSTEMS, by F. J. Mullin and E. I. Jury. [1958] [11]p. incl. diagrs. (AF 18(600)1521)

Unclassified

Presented at Pacific General meeting of the AIEE, Sacramento, Calif. Aug. 19-22, 1958.

Also published in Trans. Amer. Inst. Elec. Engineers, v. 77 (Part II): 517-524, Jan. 1959.

The phase plane is used to solve second-order sampled-data feedback systems which contain a relay and zero order hold circuit. The relay quantizes the signal applied to the linear part of the system and each quantization level gives rise to a corresponding set of trajectories in the phase plane. Between the sampling instants the output moves along one of these trajectories; however, the error signal which is applied to the relay depends only on the output and input at the end of the sampling interval; i.e., at the sampling instants. The output at the sampling instants is determined in the phase plane with the aid of two difference equations which are obtained from the time solution of the linear part of the system. This method of solution is not restricted to the study of such systems for step function inputs but may be used equally well to study the effects of sine wave inputs on the system as is illustrated in the examples of the paper. (Contractor's abstract)

CAL.13:001

California U. Electronics Research Lab., Berkeley.

INJECTION OF CONVERGENT BEAMS FOCUSED BY PERIODIC MAGNETIC FIELDS, by J. L. Palmer and C. Süskind. [1957] [8]p. incl. diagrs. (AF 49(638)102)

Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 20-23, 1957.

Published in I.R.E. WESCON Convention Record, Pt. 3: 130-137, 1957.

A design method based on analytic solutions of the equations of motion is presented that is applicable to any axially symmetric magnetic-field configuration capable of being represented by an analog computer. The specific solution employed to illustrate the method is the important case of beam focusing by periodic magnetic fields (with no flux threading the cathode). The method also

CAL.13:002 - CAL.13:004

permits the utilization of the well-known Pierce gun design. The resultant beam is optimized with regard to ripple (and hence tube gain), size (and hence heater-power requirements), and magnetic-field requirements. (Contractor's abstract)

CAL.13:002

California U. Electronics Research Lab., Berkeley.

ENTRANCE CONDITIONS FOR ELECTRON BEAMS FOCUSED BY AXIALLY SYMMETRIC MAGNETIC FIELDS, by J. L. Palmer. June 15, 1958 [64]p. incl. diagrs. tables, refs. (Series no. 60, issue no. 197) (AFOSR-TN-58-557) (AF 49(638)102) AD 158375; PB 137153 Unclassified

The differential equations of motion of an electron beam of high space charge moving through an axially symmetric magnetic field are readily solved by an analog computer. The solutions produced by the computer represent the beam radius and slope as a function of axial distance for any desired variation of axially symmetric magnetic field. The equations of motion are derived and normalized so as to be easily translated into the machine variables of the analog computer. Three particular field variations are considered in order to illustrate the method of solution. The behavior of an electron beam in the fringing magnetic field region required by Brillouin flow conditions establishes the radius and slope of the beam as it enters the region of the fringing field. Relationships between the magnitude of a periodic magnetic focusing field and its spatial-period are developed for electron beams with "minimum-ripple" boundaries. A particular fringing magnetic field at the entrance to the periodic field is determined by an electrolytic-tank analog. The variation of the fringing field with axial distance coupled with the data from the minimum ripple solutions determine the profile of the beam envelope in the region of the fringing magnetic field. By the theory of the Pierce gun the radius and slope of the beam at the anode aperture can be matched to those obtained at the entrance to both the Brillouin and the periodic-magnetic focusing systems. (Contractor's abstract)

CAL.13:003

California U. Electronics Research Lab., Berkeley.

BASIC RESEARCH IN MICROWAVE ELECTRONICS, by J. R. Singer, C. Susskind and others. Annual scientific rept. Oct. 1, 1957-Sept. 30, 1958. Oct. 31, 1958, 24p. incl. diagrs. refs. (Series no. 60; issue no. 215) (AFOSR-TN-58-989) (AF 49(638)102) AD 205909; PB 142564 Unclassified

Noise measurements are described on a backward-wave amplifier with movable gun-circuit spacing in order to study the space-charge waves in their coupling

to the backward-wave circuit. Although noise standing waves were observed, the original gun did not provide a very low noise figure. Tests on a gun with no center electrodes on a sealed-off tube showed better noise figures, but not as good as with the Currie gun, so the latter is to be used next in the variable distance tube. Theory of the effect of a virtual cathode is discussed. Design and construction of a diode for measuring noise effects in the gun region are also described. A solid-state maser using adiabatic fast passage in irradiated magnesium oxide is described. Maser gain was obtained at the end of the contract period. Theories of the effect of radiation damping on the adiabatic fast passage are given. Other planned maser experiments are discussed, including an extensive study of the best materials for the two-level maser. Studies on the entrance conditions into a periodic focusing system for electron beams are described, as is a unified point of view toward all focusing systems. (Contractor's abstract)

CAL.13:004

California U. Electronics Research Lab., Berkeley.

LAMINAR FLOW IN MAGNETICALLY FOCUSED CYLINDRICAL ELECTRON BEAMS, by J. L. Palmer. Nov. 20, 1958, 25p. incl. diagrs. (Series no. 60; issue no. 217) (AFOSR-TN-58-990) (AF 49(638)102) AD 205908 Unclassified

The behavior of a cylindrical electron beam in a magnetic field is discussed in terms of a laminar-flow model. By numerical integration of the equations of motion the maximum and minimum radii of excursion and the wave length of the undulations for each electron are presented in graphical form for various boundary conditions on the electron beam. By the proper selection of the boundary conditions, e.g., magnetic field strength at the cathode, the graphs are utilized to describe Brillouin flow, space-charge-balanced flow, immersed flow, confined flow, and, in fact, any electron flow which satisfies the laminar flow criterion. The perturbations introduced by improper injection conditions for any of the flows mentioned can be read directly from the graphs. A study of the wavelength and the amplitude of such perturbations as a function of radial position in the beam determines if a given type of flow with given injection conditions satisfies the laminar flow criterion. The sensitivity of the various types of electron flow to misadjustments of the boundary conditions is clearly revealed by the graphs, e.g., the amplitude of the undulations in Brillouin flow is very sensitive to the adjustment of the magnetic field strength, whereas, for immersed flow a similar deviation in magnetic field strength has very little effect on the amplitude of the undulations. (Contractor's abstract)

CAL. 13:005-007; CAL. 14:001; CAL. 15:001

CAL. 13:005

California U. [Electronics Research Lab., Berkeley].

PLASMA WORK (Abstract), by C. Süsskind and J. R. Whinnery. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274) [AF 49(638)102] Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

Plasmas have been studied from the point of view of providing a source of electron currents of high density for very high-power tubes. Many metallic arcs and discharges of the type occurring in the Philips Ion Gauge have been investigated with some difficulties occurring in breakdown in the transition region between the plasma and high-vacuum interaction region. The Philips Ion Gauge mechanism appears useful from the point of view of long-pulse applications. The most recent emphasis has been on the use for r-f interaction of electrons obtained from a glow discharge in combination with secondary effects from a cold cathode. The pressure in the devices is maintained by a controlled leak from the atmosphere or a pure gas while the device is continuously pumped. The ions are allowed to stay in the interaction region, causing little interference with the high frequency because of their high inertia. Very high current densities are obtained and the principle appears promising for very high power c-w tubes or pulse tubes of high average power. The first successful r-f structure used to demonstrate the principle was an inside-out magnetron using a water-cooled interdigital structure with the glow discharge and the cold cathode consisting of an 8 in. air-cooled aluminum water pipe on the outside. The tube operated at 157 mc with a power output of 50 kw continuous and 50% efficiency. The best operation was with a gas pressure of 10^{-3} to 10^{-4} mm mercury.

CAL. 13:006

California U. Electronics Research Lab., Berkeley.

PRECISION CURRENT REGULATOR USING TRANSISTORS, by S. D. Johnson and J. R. Singer. [1958] [3]p. incl. diagr. (AF 49(638)102) Unclassified

Published in Rev. Scient. Instruments, v. 29: 1026-1028, Nov. 1958.

A current regulator for electromagnets is described in detail. The regulation over periods of an hour is precise to two parts in one hundred thousand. Feedback bandpass is a few thousand cycles wide in order to eliminate high-frequency fluctuations. An auxiliary current feedback loop is used to control a generator field. (Contractor's abstract)

CAL. 13:007

California U. Electronics Research Lab., Berkeley.

ON THE DESIGN OF THE TRANSITION REGION OF AXISYMMETRIC, MAGNETICALLY FOCUSED BEAM VALVES, by V. Bevc, J. L. Palmer, and C. Süsskind. [1958] [36]p. incl. diagrs. refs. (AF 49(638)102) Unclassified

Published in Brit. Jour. I.R.E., v. 18: 696-708, Dec. 1958.

Assumption of a particular magnetic-field variation in the transition region of an axially symmetric beam-type device (e.g., klystron, traveling-wave tube) leads to the solution of the equations of electron motion by means of an analogue computer. To illustrate this novel method of solution, beam envelopes are presented for Brillouin flow, periodic magnetic focusing, and space-charge-balanced flow. By matching the beam envelopes with those obtained from the theory of the Pierce gun, dimensions are obtained for an electron gun that produces the required beam. (Contractor's abstract)

CAL. 14:001

California U. Inst. of Engineering Research, Berkeley.

APPARATUS FOR THE MEASUREMENT OF BAND AND TOTAL ABSORPTANCES OF GASES. Final rept. June 30, 1958. 64p. incl. illus. diagrs. tables, refs. (Series no. 118; issue no. 1) (AFOSR-TR-58-102) (AF 18(600)-1570) AD 162225; PB 136769 Unclassified

A description is presented of the apparatus designed and built for the measurement of thermal radiation absorptivities and emissivities of CO, CO₂, and, with modification of the gas supply system, H₂O. The range of gas temperatures is 70° F to about 2400° F, and provision has been made for future modifications which will extend the range to 3000° F. The pressure range is 0.5 to 10 atm. An optical absorption path of 15 in. is defined with an accuracy of about 1%. Instrumentation is provided for the measurement of total as well as band absorptivities from 1 to 23 μ in the infrared region of the spectrum. All optical components and all metallic structural parts are protected from the chemical activity and high temperatures of the test gases.

CAL. 15:001

California U. Inst. of Engineering Research, Berkeley.

ANALYSES FOR DIFFUSION DURING PLASTIC DEFORMATION, by J. Simmons and J. F. Dorn. Jan. 24, 1958. 19p. (Series no. 14, issue no. 1) (AFOSR-TN-58-283) (AF 49(638)58) D 154187 Unclassified

CAL. 16:001-003; CAL. 05:003

Also published in Jour. Appl. Phys., v. 29: 1308-1313, Sept. 1958.

This paper presents the general equation for self-diffusion in deforming media. Methods of analyses for determining the self-diffusivity as a function of time for prescribed strain histories are given for special cases of linear diffusion. No unrealistic assumptions relative to the constancy of the diffusivity with time are made. (Contractor's abstract)

CAL.16:001

California U. [Inst. of Engineering Research] Berkeley.

ON THE DEVELOPMENT OF GASEOUS DETONATION.
I. APPRAISAL OF THE PROBLEM, by A. K. Oppenheim and R. A. Stern. June 1958, iv, incl. illus. diagrs. tables, refs. (Technical note no. DR-1) (AFOSR-TN-58-383) (AF 49(638)166) AD 154290 Unclassified

The phenomena associated with the transition from deflagration to detonation are treated, and salient problems for future study are outlined. The history of the transition problem is traced from the discovery of the detonative mode of combustion. The study is concerned primarily with interaction phenomenon. An extensive bibliography of the literature is presented. A translation by P. A. Urtiew of selected sections from the text on *The Theory of Detonation* by Ya. B. Zel'dovich and A. S. Kompaneets is included in this report.

CAL.16:002

California U. [Inst. of Engineering Research] Berkeley.

ON THE DEVELOPMENT OF GASEOUS DETONATION.
II. ANALYSIS OF WAVE INTERACTION PHENOMENA, by A. K. Oppenheim and R. A. Stern. July 1958 [48]p. incl. illus. diagrs. tables, refs. (Technical note no. DR-2) (AFOSR-TN-58-384) (AF 49(638)166) AD 154291 Unclassified

Also published in Seventh Symposium (International) on Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworth's Scientific Publications, 1959, p. 837-850.

Salient phenomena associated with transition from deflagration to detonation are the interactions between the flame and the shock fronts generated during the process. The scant records available in the literature on shock and flame propagation during the development of detonation are used as basis for the dynamic analysis of wave phenomena occurring during the process. It is demonstrated how, by this means, the observed wave interaction phenomena can be rationalized over the whole space-time domain of the process, and, in particular, how the thermodynamic state and the wave velocity in the regime into which the flame propagates can be

determined with sufficient accuracy to deduce specific information on the reaction kinetics of a combustion front accelerating to detonation. As an example a specific analysis is carried out for a mixture of 8% propane, 50% oxygen and 42% nitrogen. It is found that the resulting energies of activation are of an order of 30 to 60 kcal/mol C_3H_8 which is in good agreement with data reported in the literature for combustion of propane under normal conditions. (Contractor's abstract)

CAL.16:003

California U. [Inst. of Engineering Research] Berkeley.

ON THE DEVELOPMENT OF GASEOUS DETONATION.
III. IONIZATION WORLD LINES, by G. J. Hecht, A. J. Laderman and others. Jan. 1959 [58]p. incl. diagrs. refs. (Technical note no. DR-3) (AFOSR-TN-58-1133) (AF 49- (638)166) AD 208082; PB 139920 Unclassified

The design and construction of an ionization detection circuit to measure ionization world lines during the development of detonation is described. The ionization processes occurring in flames, shocks, and detonations are reviewed. A critical survey of existing ionization gages is made. The evaluation of performance criteria for the present purpose is described and the design of the gage and electronic apparatus reported. The operation of the instrument is demonstrated by means of experiments performed with stoichiometric hydrogen-oxygen mixtures. It appears that the apparatus is a reliable and sufficiently accurate instrument for the measurement of ionization world lines during the development of detonation and that it can be adjusted so that within most of the operating range it registers the world lines of the flame front. (Contractor's abstract)

CAL.05:003

California U. Inst. of Engineering Research, Berkeley.

THE STUDY OF ELECTRON BEAM ATTENUATION IN AIR, by B. V. Markevitch and F. C. Hurlbut. Feb. 9, 1957 [47]p. incl. illus. tables, refs. (Rept. no. HE-150-142; series no. 20; issue no. 112) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 126618 Unclassified

An investigation of the attenuation of an electron beam in air was undertaken to examine the possible utility of such measurements for density determinations in rarefied gas streams. An apparatus is described which was designed to direct an electron beam of several kv energy through a test region into a detector. Pinholes, one at the detector entrance and one just preceding the collector plate, limit the cone of acceptance for electrons to approximately 0.002 radians. Attenuation in air of electron beams of 4 to 16 kv energy was measured at

CAL.05:004 - CAL.05:007

gas pressures of 20 to 300 μ of mercury. The results are well described by the classical logarithmic relation of Lambert. Experimental values for the effective total cross section arc represented to within 2 or 3% by the

relation $Q'(\pi) = \frac{3.6 \times 10^{-13}}{V} \text{ cm}^2$ where V is the neces-

sary accelerating potential. The corresponding mass absorption coefficient may be expressed as

$\mu = \frac{7.4 \times 10^9}{V} \text{ cm}^2/\text{gm}$. These values are approximately

10% smaller than predicted on the basis of elastic scattering alone, where the Thomas-Fermi model of the scattering center potential is assumed. The mean deviation of experimental points from the attenuation curves is of the order of 1 μ of mercury at all test pressures. The influence of multiple scattering on the constancy of the mass absorption coefficient in this geometry is apparently inappreciable. It is concluded on the basis of these considerations that an instrument employing an electron beam and collimated detector might well prove useful for aerodynamic studies in rarefied gas streams. (Contractor's abstract)

CAL.05:004

California U. Inst. of Engineering Research, Berkeley.

THE STRUCTURE OF A SHOCK WAVE IN A GAS HAVING A LONG RELAXATION TIME, by L. Talbot. Mar. 15, 1957, 23p. illus. refs. (Rept. no. HE-150-145; series no. 20, issue no. 114) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 155323

Unclassified

The shock wave structure in a gas possessing a long relaxation time for one of its internal degrees of freedom was investigated. Both the Navier-Stokes equations and a subsidiary relaxation equation were assumed to apply throughout the entire transition. The behavior of the direction field of the differential equations was examined, and one particular shock profile was completed numerically. Comparisons were made with the predictions afforded by the simpler two-stage shock model, wherein it is assumed that the shock structure consists of two distinct regions; an initial shock wave in which the fast degrees of freedom of the gas molecules undergo change while the slow degrees of freedom remain inert, followed by a long relaxation region in which the adjustment to thermodynamic equilibrium takes place. Agreement between the results of the present theory and those of the two-stage model was very good. It is concluded that for shock waves in gases having long relaxation times, calculations based on the simple two-stage model give adequate approximations for the significant parameters. (Contractor's abstract)

CAL.05:005

California U. Inst. of Engineering Research, Berkeley.

PRELIMINARY DESIGN AND TESTS OF A PLASMA JET, by W. Lai, D. H. Sloan, and L. Talbot. Technical rept. Nov. 15, 1957 [17]p. incl. illus. diagrs. tables. (Rept. no. HE-150-153; series no. 20, issue no. 115) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 150581

Unclassified

Preliminary design and test results for a plasma jet developed for the University of California Rarefied Gas Dynamics Lab. are presented. It is an argon plasma jet discharged between a carbon cathode and copper cone cathode with intermediate electrically neutral copper electrodes. The tests show that the hydrodynamic pinch and water cooling are sufficient to protect the intermediate electrodes; carbon consumption is negligible. Potential difference, current, and arc length appear to be interdependent as with a free arc. These three parameters should provide a very stable and symmetrical discharge suitable for wind tunnel research.

CAL.05:006

California U. Inst. of Engineering Research, Berkeley.

SLIP FLOW OVER A SHORT FLAT PLATE, by J. A. Laurmann. Dec. 26, 1957, 35p. incl. diagrs. (Rept. no. HE-150-152; series no. 20, issue no. 116) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 155324

Unclassified

Solutions of the compressible flow Navier-Stokes equations have been obtained for the problem of slip flow over a short flat plate at zero angle of attack by linearization for small values of the ratio of the plate length to the mean free path of the gas. A closed form solution was found possible in the compressible case; in the incompressible case a general discussion has been given in terms of splitting of the solution into transverse and longitudinal waves. It was found that the effect of viscous terms of order higher than boundary layer theory extends over distances at the leading and trailing edges of the order of $\frac{\nu}{U}$, and thus in many practical cases of interest

is negligible. (Contractor's abstract)

CAL.05:007

California U. Inst. of Engineering Research, Berkeley.

LIFT AND DRAG ON CONE CYLINDERS, by T. Nark. Dec. 30, 1957, 32p. illus. tables, refs. (Rept. no. HE-150-154; series no. 20, issue no. 117) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 155159

Unclassified

CAL.05:008 - CAL.05:011

The normal and axial forces were measured on a cone-cylinder body of revolution in a supersonic, rarefied gas flow at a Reynolds number of 4050 and a Mach number of 4.0. The angle of attack was varied to a maximum of 16° . The final results, plotted in coefficient form, were compared to Newtonian hypersonic theory for an inviscid fluid. The test was conducted at such low Reynolds numbers that the Newtonian theory did not adequately represent the axial forces, but when a skin friction correction was applied to the theory, the experimental data are within 15 percent of the predicted values. The normal force coefficient was adequately predicted by the Newtonian theory, with the maximum error above 8° being 10 percent. The results of the experimental program indicate that the axial force characteristics of a body of revolution at supersonic speeds and low Reynolds numbers, where the boundary layer is laminar, can be adequately predicted from the Newtonian hypersonic theory and a suitable skin friction correction. The Newtonian theory itself is sufficient to predict the normal force coefficient under the same flow conditions. (Contractor's abstract)

CAL.05:008

California U. Inst. of Engineering Research, Berkeley.

OXYGEN RECOMBINATION PROGRAM, by S. Hoenig. Preliminary rept. no. 1, Oct. 15-Dec. 30, 1957. Jan. 22, 1958 [22]p. incl. illus. (Rept. no. HE-150-155; series no. 20; issue no. 118) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 162606 Unclassified

An electrodeless discharge apparatus and the associated gas handling equipment have been constructed for experiments involving oxygen recombination. A probe technique for detection of atom recombination has been developed with particular emphasis on the separation of frictional heat transfer from the true heat input due to recombination. Experiments using the low pressure supersonic wind tunnel indicate that at present few if any oxygen atoms survive to enter the test section. A number of improvements are planned for the wind tunnel which, it is hoped, will remedy this situation. (Contractor's abstract)

CAL.05:009

California U. Inst. of Engineering Research, Berkeley.

A FLOATING ELEMENT WIND TUNNEL BALANCE, by W. F. Schick. July 15, 1958 [27]p. incl. illus. diagrs. tables, refs. (Rept. no. HE-150-159; series no. 20; issue no. 121) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 203700; PB 140584 Unclassified

This report describes a single component microbalance designed expressly for measuring localized drag near

the leading edge of a flat plate surface. The balance is to be used in the Low Pressures Project Wind Tunnel Number Four at the Richmond Field Station of California U. Sensitivity of the present balance is 0.1 milligram and the maximum range is greater than one gram. The sensitivity can be increased by increasing the weight of the floating element support. Balance design is based on a null system utilizing two sets of flexure pivots for model support and force measurement. There are no knife edges, rolling or sliding contact surfaces, or other devices with frictional inaccuracies used in the primary balance system. Development of this balance was prompted by the desire to study the possible effects of slip and viscous interaction on skin friction in a low density flow. (Contractor's abstract)

CAL.05:010

California U. Inst. of Engineering Research, Berkeley.

PRESSURE DISTRIBUTIONS ON FLAT PLATES AT MACH 4 AND LOW DENSITY FLOW, by J. Aroesty. July 28, 1958, 55p. refs. (Rept. no. HE-150-157; series no. 20; issue no. 120) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 203699; PB 140585 Unclassified

Induced pressures on sharp leading edge flat plates in a supersonic low density air stream were measured over the range $29.7 < Re_x < 4101$ and $3.7 < M < 4.1$.

The Reynolds number corresponding to the leading edge thickness was less than 85, insuring that blunt leading edge effects were negligible, as shown by an earlier study in the Berkeley low density wind tunnel. The measured pressure distributions agree with the analysis of Kuo to a value of $x = 2.5$, and agree with the modified tangent wedge theory to a value of $x = 3.5$. Beyond a value of x of 4, the pressures are less than those predicted by the theories, and essentially reach a constant value of $p/p_\infty = 3.5$ as the leading edge is approached. This reduction in the pressures from the levels predicted by boundary layer theory indicates a possibility of slip effects near the leading edge. (Contractor's abstract)

CAL.05:011

California U. Inst. of Engineering Research, Berkeley.

THE MOMENTUM INTEGRAL METHOD APPLIED TO THE COMPRESSIBLE BOUNDARY LAYER WITH A SLIP BOUNDARY CONDITION, by J. A. Laurmann. Aug. 20, 1958, 21p. (Rept. no. HE-150-160; series no. 20; issue no. 122) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 203734; PB 140767 Unclassified

CAL. 05:012; CAL. 06:036-038

A simple Polhausen type solution has been given for the two dimensional boundary layer equations for a flat plate with slip, and the Stewartson transformation has been used to obtain approximately the effect of compressibility. The theory, when used to compute induced pressures, yields results that give the correct trend when compared with experiment, namely a reduction of the induced pressure effect as compared with the no-slip case for large values of the parameter $M_\infty^2 / \sqrt{Re_\infty}$. (Contractor's abstract)

CAL.05:012

California U. Inst. of Engineering Research, Berkeley.

DESIGN CONSIDERATIONS AND INITIAL EVALUATION OF MODEL B PLASMA GENERATOR, by W. Lai, J. Gustavson, and L. Talbot. Sept. 5, 1958 [13]p. incl. illus. tables. (Rept. no. ME-150-161; series no. 20; issue no. 123) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-22245) AD 204400 Unclassified

An improved dc arc plasma generator is described. The general operation of the unit is as follows: The dc arc burns between the rear electrode, which is the cathode, and an anode, which can be either the expansion nozzle or the constricting orifice (constrictor). Gas is introduced in the arc chamber, passes through the arc, and expands through the constrictor/nozzle assembly into the test chamber, which is maintained continuously at a low pressure by vacuum pumps. In passing through the electrode gap, the gas maintains the arc and is heated to a high temperature. The resultant flow is a supersonic low density jet, of high total enthalpy. (ASTIA abstract)

CAL.06:036

California U. Inst. of Engineering Research, Berkeley.

RECENT OBSERVATIONS OF SLIP IN RAREFIED GAS FLOWS (Abstract), by F. C. Hurlbut and E. Merlic [1957] [1]p. (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under N7onr-29503) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 45, Jan. 30, 1957.

Values of the tangential momentum transfer coefficient σ have been determined from measurements of drag in a rotating cylinder apparatus. Laminar flows of various pure gases and of air at pressures in the range 15 to 250 microns Hg were established between concentric cylinders. Values of the momentum transfer coefficient were found to be dependent on the pressure history of the

apparatus. When the cylinder surface was held at 0.01 micron Hg for a period of several days, values of σ of approximately 0.9 were measured for air. When the surface was held at a pressure of 250 microns, Hg values of σ were found to decrease with time reaching approximately 0.6 after a number of days. These results are considered in light of other available evidence including that obtained from measurements of molecular scattering at the surface in a molecular beam apparatus.

CAL.06:037

California U. [Inst. of Engineering Research] Berkeley.

STUDIES OF MOLECULAR SCATTERING AT THE SOLID SURFACE, by F. C. Hurlbut. [1957] [7]p. incl. diagrs. [Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under N7onr-29503] Unclassified

Published in Jour. Appl. Phys., v. 28: 844-850, Aug. 1957.

Experimental studies of molecular scattering at the gas-surface interface are described in which molecular beams of N_2 were scattered at surfaces of steel, aluminum, and glass. Polar surveys of the issuing molecular flux indicate the scattering to be well represented by a cosine distribution in most cases. A moderate deviation from such a distribution was observed in the case of the glass- N_2 interaction. It is shown how measurements of scattering at the surface may be used to derive values of the momentum transfer coefficient, $f(s)$, in a rarefied gas flow where s is defined as the ratio of the mass speed of the flow to the most probable thermal speed of the molecules. In order to complete the calculation where scattering information alone is available from experiment, assumptions must be made relating to the energy exchange at the surface. In the case of the present calculation, where a surface interaction model was formed in part from the glass- N_2 scattering data, two extremal assumptions relating to the energy exchange lead to values of $f(s)$ of approximately 0.97 at $s = 0.1$. (Contractor's abstract)

CAL.06:038

California U. [Inst. of Engineering Research] Berkeley.

AN IONIZATION GAUGE DETECTOR FOR MOLECULAR BEAMS (Abstract), by F. C. Hurlbut. [1958] [1]p. (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under [N7onr-29503]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

CAL. 06:039; CAL. 17:001;
CAL. 18:001, 002

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 58,
Jan. 29, 1958.

The application of ionization gauges to the detection of molecular beams is discussed and the performance of an existing detection system for surface scattering studies is described. Beams of argon and of nitrogen have been employed to the present writing. Minimum resolvable pressure increments within the gauge volume due to the beam are of the order of 10^{-11} mm Hg. Limitations of the system are considered in relation to those of other currently available detection systems.

CAL.06:039

California U. [Inst. of Engineering Research] Berkeley.

THE FREE MOLECULE PROBE AND ITS USE FOR THE STUDY OF LEADING EDGE FLOWS, by J. A. Laurmann. [1958] [9]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under [N7onr-26503])
Unclassified

Published in Phys. Fluids, v. 1: 469-477, Nov.-Dec. 1958.

The development of a free molecule probe for use as an instrument in the investigation of two dimensional rarefied gas flow fields is described. The probe consists of a cross-stream cylindrical wire of diameter small compared with the mean free path of the gas. Measurement of the probe temperature and heat transfer characteristics yields information that can be related theoretically to the state of the flowing gas. This paper describes the use of such information in the study of the qualitative nature of the supersonic flow about sharp leading edges in regions where rarefaction, slip, and boundary layer-shock wave interaction effects are important. The results showed clearly the effect of increasing density. Thus, at the lowest densities and Mach numbers, a clearly defined shock wave and boundary layer emerged from a region of mixed compressive and viscous action at the leading edge, while at the higher densities and Mach numbers there was a large region of strong boundary layer-shock wave interaction and a considerable delay in the formation of clearly defined shock wave. (Contractor's abstract)

CAL.17:001

California U. Minerals Research Lab., Berkeley.

INTERNAL STRESSES IN MODEL CERAMIC SYSTEMS, by R. M. Fulrath. Technical progress rept. no. 1. Mar. 30, 1958. [29]p. incl. illus. diagrs. tables. (AFOSR-TN-58-724) (AF 49(638)4) AD 200867
Unclassified

Presented at meeting of the Amer. Ceramic Soc., Alfred, N. Y., Sept. 10, 1957.

Also published in Jour. Amer. Ceramic Soc., v. 42: 423-429, Sept. 1959.

Model ceramic systems of crystals and glass fabricated by vacuum hot compaction have been used to study methods of detection of internal stress on the crystalline phase. Effects of the volume fraction of the glass, compaction temperature and time, and crystal particle size in modifying induced internal stress are presented. These effects together with x-ray diffraction and wetting studies indicate that internal stress development is closely connected to wetting of the crystal by the glass and the formation of a second crystalline phase. Limited results regarding internal stress effects on strength of ceramic bodies indicate increasing internal stress on the crystal phase decreases the modulus of rupture when the particle size of the crystal component remains constant. The results indicate that the full potential of ceramic systems may not be realized with the presence of internal stress. (Contractor's abstract)

CAL.18:001

California U. Minerals Research Lab., Berkeley.

THE MECHANICAL PROPERTIES OF SOME IONIC MATERIALS, AND THE EFFECT OF SURFACE CONDITIONS ON THEIR ROOM TEMPERATURE DUCTILITY, by E. R. Parker, J. A. Pask and others. Nov. 1957 [24]p. incl. illus. diagrs. refs. (Technical rept. no. 1; Series no. 109; issue no. 1) (AFOSR-TN-57-731) (AF 49(638)-56) AD 136715
Unclassified

The ductility of several freshly cleaved solids having cubic crystal symmetry has been measured by static bend-testing. Freshly prepared samples were found to be substantially ductile. Oxygen and nitrogen environments produced surface brittleness. Two materials, LiF and MgO, did not show air embrittlement. Controlled impurity tests on LiF showed that there is a marked decrease in ductility with impurity concentration increase.

CAL.18:002

California U. Minerals Research Lab., Berkeley.

THE EFFECT OF IMPURITIES AND HEAT TREATMENT ON THE DUCTILITY OF MgO, by A. E. Gorum, W. Luhman, and J. A. Pask. Dec. 1958 [19]p. incl. illus. diagrs. (Technical rept. no. 2; series no. 109; issue no. 2) (AFOSR-TN-58-1061) (AF 49(638)56) AD 207221; PB 139487
Unclassified

Also published in Jour. Amer. Ceram. Soc., v. 43: 241-245, May 1960.

CAL.18:003; CLA.04:004, 005

The effects of impurities and thermal history on the formation and growth of slide bands in MgO crystals were investigated. Slip-band formation and growth was studied in a gold-coated specimen. When slip occurs, dislocations accumulate in the slip bands, interactions take place, and slip decreases or stops in these regions of a crystal. The slip then transfers to another area. An etch pit technique verified that slip bands act as barriers to slip on other systems. Impact, bending, and tensile data were obtained before and after heating MgO crystals to 2200°C for one-half hour to study the effects of heating on properties. An MgO crystal containing either 30 or 3000 ppm Fe had a much higher flow stress than a crystal with 10 ppm Fe; however, the ductility for the crystal with 30 ppm Fe was much lower. Increasing the Fe content to 3000 ppm caused an additional but proportionately smaller effect. Relatively small amounts of impurity can greatly affect the strength and ductility of MgO. The impurity may move to and from dislocations, i.e., moving away during heating and collecting again during cooling if the rate is slow enough. Heat treatment apparently causes effective pinning of the dislocations in the order slip bands. The more dislocations present in a structure, the greater is the effect on strength and ductility. (ASTIA abstract)

CAL.18:003

California U. Minerals Research Lab., Berkeley.

EFFECT OF SURFACE CONDITIONS ON ROOM-TEMPERATURE DUCTILITY OF IONIC CRYSTALS, by A. E. Gorum, E. R. Parker, and J. A. Pask. [1958] [4]p. incl. illus. diagrs. refs. [AF 49(638)56]

Unclassified

Published in Jour. Amer. Ceramic Soc., v. 41: 161-164, May 1, 1958.

With the progress on dislocation theories and a better understanding of flow phenomena, it was predicted that a class of materials normally considered to be brittle, namely, ionic solids having cubic crystal structures, would possess a degree of ductility. Experimental results on a number of ionic materials indicate that face-centered cubic and body-centered cubic ionic materials can exhibit a considerable amount of ductility under controlled conditions. It was found that these materials are inherently ductile rather than brittle and that there appear to be two factors, a surface reaction with components of the air and impurity concentration, that exert control over the ductility. The examination of the air embrittlement indicated that oxygen and nitrogen are the cause of decreased ductility in water-soluble salts such as KCl and KBr. The effect on the surface can be inhibited by surface treatment or by immersion in oil. Other materials such as MgO and LiF do not seem to exhibit a surface embrittlement. MgO does, however, show a time-dependent ductility that is attributed to the presence of impurities. (Contractor's abstract)

CLA.04:004

California U. [Dept. of Engineering] Los Angeles.

A MODEL OF HETEROGENEOUS SLIP MECHANISM IN METALS (Abstract), by N. E. Friedman and D. Rosenthal. [1957] [1]p. (AF 18(600)1022)

Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 372, Dec. 19, 1957.

Heterogeneous grain deformation, easy and difficult slip, orientation dependence of lattice strains have led to a revision of Taylor's homogeneous five slip mechanism in plastically-deformed polycrystalline metals as follows. The deformation is assumed to start as a single slip in the grain interior and revert to multislip near the boundary in the fraction mV of the grain volume, V . If deformation bands are disregarded, a linear variation of the rotation vector can be assumed in each grain. The displacement vector mV is then the solution of Laplace's equation with conditions of single slip on the inner boundary and uniaxial tension on the outer boundary. Because of the intractable form of the problem the strains in the interior are estimated from the known values on the boundaries. Following Bishop's analysis a monotonic variation with m is found for σ/t (applied/resolved shear stress ratio) in almost every orientation. Large orientation dependence of lattice strains is thus explainable by variation of m as well as variation of resolved shear stress-strain relationships.

CLA.04:005

California U. [Dept. of Engineering] Los Angeles.

X-RAY EVIDENCE OF HETEROGENEOUS PLASTIC DEFORMATION IN METALS (Abstract), by D. Rosenthal and W. B. Gruben. [1957] [1]p. (AF 18(600)1022)

Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 372, Dec. 19, 1957.

Lattice strains in a polycrystalline aluminum alloy were determined under uniaxial compression from shifts of various x-ray diffraction peaks. In the plastic range the results indicated: (a) easy and difficult slip, (b) less strain hardening in the surface grains than in the bulk of metal, and (c) large variation of strain hardening with x-ray orientation. These and other reported discrepancies with Taylor's homogeneous five slip mechanism of plastic deformation have led to a modified, heterogeneous,

CLA. 04:006; CLA. 05:001-003

model of slip. In this model the variation of strain hardening with position and orientation is shown to be consistent with the behavior of single crystals. Also, resolved shear stress-strain relationships for various grain aggregates can be derived from lattice strain data with the help of the model. These relationships are found to be within the limits of scatter obtained for single crystals. (Contractor's abstract, modified)

CLA.04:006

California U. Dept. of Engineering, Los Angeles.

PLASTIC DEFORMATION OF SURFACE AGGREGATES IN F. C. C. METALS, by D. Rosenthal, N. E. Friedmann and others. Feb. 1958, 64p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-48) (AF 18(600)1022) AD 154198
Unclassified

Deviations from proportionality in the lattice strain-stress diagrams obtained from x-ray diffraction study of plastically deformed polycrystalline aggregates cannot be reconciled with Taylor's homogeneous five slip mechanism of plastic flow. To account for the observed discrepancies a heterogeneous slip mechanism is postulated. Part I describes the relevant theory and derives a lower bound for the expression of the applied stress causing yielding of a particular crystalline aggregate in uniaxial loading. Good qualitative agreement is obtained in Part II when these expressions are compared with the results of an x-ray diffraction study of polycrystalline Aluminum alloy. Within the scope of this study it is concluded that the proposed theory is particularly suited to the analysis of plastic behavior of surface grain aggregates at the initial stages of plastic deformation. A note appended to this report describes a novel technique enabling the study to be extended to large plastic deformations. (Precision Lattice Parameter Measurement of Imperfect Crystals, by R. Asimow.) (Contractor's abstract)

CLA.05:001

California U. Dept. of Engineering, Los Angeles.

PLASTIC DEFORMATION OF FACE-CENTERED CUBIC METALS, by T. H. Lin, L. Meirovitch, and B. Lieb. Nov. 1957, 27p. incl. diagrs. tables, refs. (AFOSR-TN-58-37) (AF 49(638)20) AD 148076
Unclassified

The method of minimum sums of slips or of maximum work results in a number of combinations of 5 slips available for the given imposed strain on the crystal. These combinations can exist in different proportions, so that there are not only a number of rotations corresponding to the number of combinations of 5 slip systems, but a range of rotations. In a number of cases the range covers rotation vectors in all directions in the stereographic triangle. The method of considering the elastic strain determines more definitely the rotations

of a crystal under a given strain, and this method is applied to the calculation of the texture of aluminum polycrystal subject to axial deformation. The observed texture of 70-30 brass does not agree with the texture calculated by considering elastic strains.

CLA.05:002

California U. Dept. of Engineering, Los Angeles.

A POLYAXIAL INELASTIC STRESS-STRAIN RELATIONSHIP OF FACE-CENTERED CUBIC METALS, by T. H. Lin. Jan. 1958, 18p. incl. diagrs. refs. (AFOSR-TN-58-151) (AF 49(638)20) AD 152177
Unclassified

A simplified model is considered in which crystals with a common slip plane are treated as one group. Each group is subject to the aggregate stress and slide together on the common plane independent of other groups. The error in stress-strain relations introduced by this model is decreased by using polycrystal uniaxial test data instead of single crystal tests to find the shear stress vs plastic strain on a plane. For this model there is a yield curve on every plane. Each point on the yield curve gives a tangent plane to the yield surface in the 6-dimensional stress space. It gives a smooth yield curve on each plane but a corner in the yield surface. Because of latent hardening, the displacement of the yield curve on one plane induces the motion of many yield curves on the planes. A number of inelastic loadings are calculated, and the results show that the present theory gives better agreement than previous theories. (Contractor's abstract)

CLA.05:003

California U. [Dept. of Engineering] Los Angeles.

ON STRESS-STRAIN RELATIONS BASED ON SLIPS, by T. H. Lin. [1958] 7p. incl. diagrs. refs. (AF 49-638)20
Unclassified

Published in Proc. Third U. S. Nat'l. Congress of Appl. Mech., Brown U., Providence, R. I. (June 11-14, 1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 581-587.

Basic assumptions used in the slip polyaxial stress-strain relations of Batdorf and Budiansky (Jour. Appl. Mech., v. 323, Dec. 1954) are compared to those assumptions in the slip stress-strain relations proposed by the writer. The latter slip theory is modified to include the effect of latent hardening. A number of inelastic loadings have been calculated. For the cases calculated, the present theory gives better agreement than the previous theories. (Contractor's abstract)

CLA.06:001, 002; CLA.07:001;
CUP.01:001; CAR.04:014, 015

CLA.06:001

California U. School of Medicine, Los Angeles.

THE EFFECT OF CEREBRAL ANOXIA ON BEHAVIOR AND BRAIN FUNCTION IN TRAINED ANIMALS, by R. Gunter. Mar. 15, 1957 [16]p. incl. diagrs. tables. (AF 18(603)14) Unclassified

Fourteen cats were trained to perform various tasks. Careful records were kept of their performances. Also their visual intensity thresholds, discrimination reversals, and paw preferences were determined. These observations were later compared with post-anoxia determinations.

CLA.06:002

California U. School of Medicine, Los Angeles.

PERSISTENCE OF ELECTRICAL ACTIVITY IN THE HEART AFTER CLINICAL DEATH, by P. Sabawala, R. Gunter, and R. D. Walter. [1957] [10]p. incl. diagrs. (AF 18(603)14) Unclassified

Electrical activity has been known to persist in the heart long after other signs point to the "death" of the animal. A description is given of an experiment with one cat that formed part of a large group subjected to acute, total anoxic anoxia. The data presented suggest that an apparently normal EKG was obtained from a heart which was not performing efficiently as a pump. (Contractor's abstract)

CLA.07:001

California U. [Santa Barbara Coll.] Goleta.

HIGH-ENERGY NEUTRON CROSS SECTIONS (Abstract), by P. H. Barrett. [1957] [1]p. [AF 49(638)9] Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 379-380, Dec. 16, 1957.

A high-energy beam of neutrons was produced by 6.2-bev protons from the Bevatron striking a polyethylene target. The absorption cross section for neutrons in this beam has been measured for Pb, Al, Cu, and nuclear emulsion. The neutrons are detected by nuclear emulsions using the density of stars and star size as the basis of the analysis. Cross sections obtained will be compared with other measurements of cross section for high-energy neutrons and protons.

CUP.01:001

Cambridge U. Press, New York.

JOURNAL OF FLUID MECHANICS, ed. by G. K. Batchelor. July 1, 1958-June 30, 1960. (MIPR-690-59-3 and Nonr-254800) Unclassified

This periodical is devoted exclusively to theoretical and experimental research investigations of all aspects of fluid mechanics. The contributors include a large percentage of the leading American and British research workers in fluid mechanics. The subjects include hydrodynamics (both laminar and turbulent flows); subsonic, supersonic, and hypersonic gas dynamics; wave motions; heat transfer; magnetohydrodynamics, etc.

CAR.04:014

Carnegie Inst. of Tech. Dept. of Mathematics, Pittsburgh, Pa.

THE LEAST EIGENVALUE OF HILL'S EQUATION, by R. A. Moore. Jan. 1957 [18]p. (Technical rept. no. 14) (AFOSR-TN-57-48; (AF 18(600)1138) AD 115087 Unclassified

Also published in J.our. Analyse Math. (Jerusalem), v. 5: 183-186, 1956/1957.

The functional dependence of the least eigenvalue ($-a$) of Hill's equation

$$y'' + (-a + bq(x))y = 0$$

on the parameter b is investigated. Here q is a periodic function of period one with mean zero, and y is required to be periodic with period one. By using various Sturmian theorems, the author proves the following and other similar properties of the function $a(b)$: $a(b)$ is convex, $a(0) = a'(0) = 0$, and

$$a(b) \leq \begin{cases} mb - m^2 w^{-2} & (b \leq 2mw^{-2}) \\ \frac{1}{2} w^2 b^2 & (2mw^{-2} \leq b \leq 2Mw^{-2}) \\ Mb - M^2 w^{-2} & (b \geq 2Mw^{-2}) \end{cases}$$

where m and M are the minimum and maximum values of q , while w is the maximum value of $|\int_{\xi_1}^{\xi_2} q(x)dx|$ for $0 \leq \xi_1 \leq \xi_2 \leq 1$. (Math. Rev. abstract)

CAR.04:015

Carnegie Inst. of Tech. Dept. of Mathematics, Pittsburgh, Pa.

NIM-TYPE GAMES, by E. W. Adams and D. C. Benson. Dec. 1956 [47]p. incl. tables. (Technical rept. no. 13) (AFOSR-TN-57-50) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1138 and Office of Ordnance Research) AD 115089

Unclassified

CAR.04:016 - CAR.04:018

A general axiomatic characterization of the class of games similar to Nim is given and the general properties of the equivalence classes of positions are mentioned. The most general Nim-type game is shown to be isomorphic to an "ordinal-Nim game" in which the positions are arbitrary finite sets of finite and denumerable ordinal numbers closed under a "natural sum" operation and in which a move transforms one ordinal number "position" to a lower ordinal number, creating a problem in game analysis in the theory of finite and denumerable ordinal numbers. The general theory is applied to Nim, Kaylee, and some variations of Kaylee. The determination of the equivalence classes for Kaylee and its variations is programmed for a digital computer (I.B.M. 650). The computations with certain general considerations determine the equivalence classes for Kaylee and several variations. In some of the equivalence classes a surprising periodicity is shown to hold for some of the particular variations analyzed.

the dual of $C(X)$ into the sub measure ring \mathcal{M}_0 of \mathcal{Q} determined by \mathcal{U}_0 such that $\int_A h = \int_A \bar{y}$ for each $A \in \mathcal{M}_0$; \bar{y} is the mapping of U into S , the dual of a real separable Banach space B , such that for each point x in B , $(x\bar{y}(w))$ is a \mathcal{U}_0 -measurable function of w , and $\int (x\bar{y}(w)) du(w)$ exists. (ASTIA abstract)

CAR.04:017

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON THE OSCILLATION OF SOLUTIONS OF SELF-ADJOINT LINEAR DIFFERENTIAL EQUATIONS OF THE FOURTH ORDER, by W. Leighton and Z. Nehari. Mar. 1957, 88p. (Technical rept. no. 16) (AFOSR-TN-57-102) (AF 18(600)1138) AD 120451 Unclassified

Also published in Trans. Amer. Math. Soc., v. 89: 325-377, Nov. 1958.

A systematic investigation of the oscillation properties of the solutions of certain classes of self adjoint linear differential equations of fourth order is given. The most general equation of this type is of the form $(r(x)y'')'' + (q(x)y')' + p(x)y = 0$, $r(x) > 0$, where, in the interval considered, $r(x)$, $q(x)$ and $p(x)$ are functions of C'' , C' and C , respectively and the prime denotes differentiation with respect to x . The functions are assumed to be defined and to belong to the classes indicated in the interval $(0, \infty)$. Part I is devoted to the study of the solutions of $(r(x)y'') - p(x)y = 0$, $r(x) > 0$, $p(x) > 0$ and Part II to the study of the solutions of $(r(x)y'')'' + p(x)y = 0$, $r(x) > 0$, $p(x) > 0$. A number of transformations of the general equation including transformations into the equations of Parts I and II are also studied.

CAR.04:018

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

A FUNCTION-THEORETIC SOLUTION OF CERTAIN INTEGRAL EQUATIONS I, by A. E. Heins and R. C. MacCamy. May 1957 [16]p. (Technical rept. no. 18) (AFOSR-TN-57-236) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1138 and Office of Ordnance Research under DA 36-061-ORD-490) AD 126533 Unclassified

Also published in Quart. Jour. Math., v. 9: 132-143, June 1958.

Consideration is given to the solution, by function theoretic methods, of a certain type of integral equation arising in the study of boundary problems for elliptic partial differential equations in two variables. The equation is converted into a functional relation for a multiple-valued analytic function defined on Riemann surface and

CAR.04:016

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

CONDITIONAL PROBABILITY DISTRIBUTION IN THE WIDE SENSE, by L. E. Dubins. Feb. 1957, 9p. incl. refs. (Technical rept. no. 15) (AFOSR-TN-57-80) (AF 18(600)1138) AD 120426 Unclassified

Also published in Proc. Amer. Math. Soc., v. 8: 1088-1092, Dec. 1957.

Proof is given that the result of Doob (Stochastic Processes, New York, 1953) relative to a conditional distribution in the wide sense holds if X is any locally compact Hausdorff space whose one point compactification is metrizable. The following main theorem is proved: Let $\mathcal{Q} = [U, \mathcal{U}, u]$ be a probability space and \mathcal{U}_0 a σ -subfield of \mathcal{U} . Suppose X is a locally compact Hausdorff space whose one point compactification is metrizable, and let y be a measurable transformation of U into X (i.e. $y^{-1}(Y) \in \mathcal{U}$ for each Baire subset Y of X); then there exists a function p of Y and w for which conditions (i), (ii), and (iii) hold. (i) $p(Y, w)$ is, for each fixed w , a probability measure defined on the Baire subsets of X ; (ii) $p(Y, w)$ is, for each Y , a function measurable relative to \mathcal{U}_0 ; and (iii) $\int_A p(Y, w) du(w) = u(A \cap y^{-1}(Y))$ for each $A \in \mathcal{U}_0$ and each Baire subset Y of X . A is a set of variables w . If X is only assumed to be a locally compact Hausdorff space then $C(X)$, the Banach space of all continuous real functions of X which vanish at ∞ , need not be separable and the conditional expectation of f with respect to \mathcal{U}_0 need not be a point function but would be a generalized random variable. With technical modifications in the proof of the main theorem, it can be shown that there exists a σ -algebra homomorphism h defined on the weak star measurable subsets of

CAR.04:019 - CAR.04:021

the solution of this relation obtained. The method is carried out in detail for the integral equation of the Sommerfeld half-plane problem. (Contractor's abstract)

CAR.04:019

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON THE FOUNDATION OF THE MECHANICS OF CONTINUOUS MEDIA, by W. Noll. June 1957, 68p. incl. diagrs. (Technical rept. no. 17) (AFOSR-TN-57-352) (AF 18(600)1138) AD 132425 Unclassified

An attempt is made to introduce the same level of rigor and clarity into the theory of continuum mechanics as is now customary in pure mathematics. A continuous body is defined as a piece of a differentiable manifold which is also a measure space, and forces are defined in terms of vector measures, with precise definitions given for motions. The reaction principle for contact forces and the stress principle are proved. A number of invariance requirements are postulated for the general theory of material behavior. This is done from a point of view which renders classical mechanics a relativistic theory in that there are no preferred frames of reference. The general theory of material properties is discussed with such properties being characterized by constitutive equations. The most general form of a constitutive equation for stresses is investigated.

CAR.04:020

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

THE NUMERICAL SOLUTION OF SINGULAR INTEGRAL EQUATIONS, by R. C. MacCamy. Sept. 1957, 22p. (Technical rept. no. 19) (AFOSR-TN-57-515) (AF 18(600)1138) AD 136500 Unclassified

An investigation is made of the singular behavior of the numerical solutions of integral equations at the ends of the interval of integration. The integral equations are translated into functional relations for multivalued analytic functions of a complex variable. The information obtained about the structure of the analytic function is translated back into facts concerning the solutions of the integral equations. Three types of equations, all for $0 < x < 2$, are studied: (I)

$$\int_0^2 [A(x,t)(x-t)^{-1} + B(x,t)\log|x-t| + C(x,t)] f(t)dt = g(x);$$

$$(II) f(x) + (\pi)^{-1} \int_0^2 [A(x,t)(x-t)^{-1} + B(x,t)\log|x-t| +$$

$$C(x,t)] f(t)dt = g(x); (III) f(x) + (\pi)^{-1} \int_0^2 [A(x,t)(x-t)^{-1} +$$

$$B(x,t)\log|x-t| + C(x,t)] f'(t)dt = g(x). \text{ In each case } g(x)$$

is to be analytic for $0 < |x| < 2$ and A, B , and C are to be analytic for $0 < |x|, |t| < 2$. Two cases are considered: (1) $A(x,z) \neq 0$ for $0 < |z| < 2$, $A(0,0)$ real; and (2) $A(x,z) = 0$, $B(x,z) \neq 0$ for $0 < |z| < 2$, $B(0,0)$ real. The main result is the following: Let \mathcal{F} denote the set of all functions $f(x)$ continuous and satisfying a Hölder condition on $0 < x < 2$ and such that $[x(2-x)]^\alpha f(x)$ is continuous at $x = 0$ and 2 , $\alpha < 1$; then $f \in \mathcal{F}$ is a solution of I and II, and f is a solution of III with $f' \in \mathcal{F}$ with $f(x)$ explicitly given for each case under each type of equation.

CAR.04:021

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON THE PRINCIPAL FREQUENCY OF A MEMBRANE, by Z. Nehari. Nov. 1957 [12]p. (Technical rept. no. 20) (AFOSR-TN-57-713) (AF 18(600)1138) AD 136706 Unclassified

Also published in Pacific Jour. Math., v. 8: 285-293, 1958.

A study is made of the possible generalizations of Rayleigh's theorem to the case of nonhomogeneous membranes: Rayleigh's theorem states that the homogeneous circular membrane has the lowest principal frequency among all homogeneous membranes of the same mass. Certain restrictions are imposed on the density distribution of the nonhomogeneous membrane because the principal frequency of a membrane of given mass can be made arbitrarily small if enough of the mass is concentrated in a small area interior to the simply connected region in the given plane. Conditions are imposed which prevent the excessive accumulation of mass at interior points of the membrane. Proofs are given for the following theorems. Theorem 1. If λ is the principal frequency of a membrane of given mass whose density distribution $p(x,y)$ is such that $\log p(x,y)$ is subharmonic, then $\lambda > \lambda_0$, where λ_0 is the principal frequency of a homogeneous circular membrane of the same mass. Theorem 2. If λ is the principal frequency of a circular membrane of given mass whose density distribution $p(x,y)$ is superharmonic, then $\lambda > \lambda_0$, where λ_0 is the principal frequency of a homogeneous circular membrane of the same mass. Theorem 3. Let α be an analytic subarc of C which is concave with respect to D . If λ denotes the principal frequency of a homogeneous membrane whose boundary is free along α and fixed along $C-\alpha$, then $\lambda > \lambda_0$, where λ_0 is the principal frequency of a homogeneous semi-circular membrane of equal mass whose boundary is free along the diameter and fixed along the semicircle.

CAR. 04:022, 023; CAR. 09:001-003

CAR.04:022

Carnegie Inst. of Tech. [Dept. of Mathematics]
Pittsburgh, Pa.

ON EXTERIOR BOUNDARY VALUE PROBLEMS IN
LINEAR ELASTICITY, by R. J. Duffin and W. Noll.
[1958] [6]p. (Sponsored jointly by Air Force Office of
Scientific Research under AF 18(600)1138 and Office of
Ordnance Research under DA 36-061-ORD-490)

Unclassified

Published in Arch. Rational Mech. Anal., v. 2: 191-196,
Oct. 31, 1958.

Uniqueness theorems for three-dimensional equations
of classical elasticity are proven for: (a) A region
external to closed surfaces when the displacement is
prescribed on the surfaces and tends uniformly to zero
at infinity; (b) a region external to an infinite cylinder
where the (plane) displacement is prescribed on the
cylinder and is bounded at infinity. The difference between
the results obtained and uniqueness theorems
previously known lies in the conditions at infinity.
Uniqueness theorems are also proved for infinite elastic
plates bounded internally by a number of smooth curves.
(Math. Rev. abstract)

CAR.04:023

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON BABINET'S PRINCIPLE, by R. C. MacCamy. [1958]
[9]p. (AF 18(600)1138; continued by AF 49(638)227)

Unclassified

Published in Canad. Jour. Math., v. 10: 632-640, 1958.

The principle of Babinet in acoustic and electromagnetic
diffraction theory states the equivalences of an aperture
S in a plane screen and a plane obstacle occupying the
position of S. The author discusses generalizations of
this principle, pointing out that both the boundary conditions
and partial differential equations may be changed,
but that the obstacle must be plane. The emphasis is
on the integral equation formulation of boundary value
problems. Two examples are discussed. (Math. Rev.
abstract)

CAR.09:001

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

A FUNCTION THEORETIC SOLUTION OF CERTAIN
INTEGRAL EQUATIONS II, by A. E. Heins and R. C.
MacCamy. Mar. 1958, 20p. (Technical rept. no. 20)
(AFOSR-TN-58-250) (Sponsored jointly by Air Force
Office of Scientific Research under AF 49(638)227;

continuation of AF 18(600)1138 and Office of Ordnance
Research under DA 36-061-ORD-490) AD 154153;
PB 135991

Unclassified

Studies were continued on the solution of integral equations
by translation into functional relations for
multiple-valued analytic functions on a Riemann surface.
Two homogeneous equations of second kind are solved,
one with a difference kernel having a logarithmic singularity
and the other with a sum kernel. Extensive use is
made of the Laplace transform of an analytic function.
(Contractor's abstract)

CAR.09:002

Carnegie Inst. of Tech. Dept. of Mathematics
Pittsburgh, Pa.

OSCILLATION CRITERIA FOR FOURTH-ORDER LINEAR
DIFFERENTIAL EQUATIONS, by H. Howard. June 1958,
42p. (Technical rept. no. 21) (AFOSR-TN-58-421)
(AF 49(638)227) AD 158224; PB 135364

Unclassified

Also published in Trans. Amer. Math. Soc., v. 66: 296-
311, Aug. 1960.

The oscillation problem is discussed for a particular
class of self-adjoint differential equations of the fourth
order of the form: $(r(x)y''(x))'' = p(x)y(x)$. The basic
technique consists in relating this problem to a certain
eigenvalue problem for an appropriate differential system.
A variety of comparison theorems for both fourth
order and second order equations are derived by the use
of the basic eigenvalue criteria for oscillation.

CAR.09:003

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

NON-OSCILLATION THEOREMS FOR A CLASS OF
NON-LINEAR DIFFERENTIAL EQUATIONS, by R. A.
Moore and Z. Nehari. July 1958, 34p. (Technical rept.
no. 23) (AFOSR-TN-58-459) (AF 49(638)227)
AD 158286

Unclassified

Also published in Trans. Amer. Math. Soc., v. 93: 30-
52, Oct. 1959.

Differential equations of the form $y'' + p(x)y^{2n+1} = 0$,
where $p(x)$ is positive and continuous in $(0, \infty)$ and n is a
positive integer, are studied. The nature of the solutions
for this kind of equation is analyzed in terms of minimizing
the generalized Rayleigh quotient

$$J(y) = \frac{\left(\int_a^b y^{1/2} dx \right)^{n+1}}{\int_a^b p y^{2n+2} dx}$$

for suitable homogeneous boundary conditions.

AIR FORCE SCIENTIFIC RESEARCH

CAR.09:004; CAR.07:002;
CAR.08:005-007

CAR.09:004

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

AXIALLY SYMMETRIC SOLUTIONS OF ELLIPTIC DIFFERENTIAL EQUATIONS, by R. C. MacCamy and A. E. Heins. Nov. 1958 [35]p. incl. diagrs. refs. (Technical rept. no. 24) (AFOSR-TN-58-922) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(838)227 and Office of Ordnance Research under DA 36-061-ORD-490) AD 204558; PB 137775

Unclassified

An investigation is made of the representation of solutions of the axially-symmetric elliptic equations. The representations are derived by exploiting the connection between such equations and singular initial value problems for hyperbolic equations. The result is a correspondence between solutions of the elliptic equations and functions of a complex variable. Certain boundary-value problems for the elliptic equations are solved explicitly or semi-explicitly with the aid of these representations. (Contractor's abstract)

CAR.07:002

Carnegie Inst. of Tech. [Metals Research Lab.]
Pittsburgh, Pa.

RESEARCH ON KINETICS AND MECHANISM IN METAL REFINING SYSTEMS, by C. L. McCabe and J. Morgan. Final rept. Feb. 12, 1957 [10]p. incl. diagrs. table, refs. (AFOSR-TR-57-9) (AF 18(600)1147) AD 120402

Unclassified

This report summarizes the findings of the following investigations: (1) the mechanism for the oxidation of metallic sulfides to oxides and/or sulfates; and (2) the mechanism for the reduction of metallic oxides to the corresponding metal or metal carbide. Oxide formation by the roasting of metallic sulfides, sulfate formation by the roasting of metallic sulfides, and the reduction of tungsten and molybdenum dioxide by carbon are discussed.

CAR.08:005

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

OXIDATION OF NICKEL-COBALT ALLOYS IN THE RANGE OF CURIE TEMPERATURES, by W. W. Smeltzer. Apr. 15, 1957, 18p. illus. tables, refs. (AFOSR-TN-57-187) (AF 18(600)1572) AD 126460

Unclassified

Also published in Acta Metallurgica, v. 7: 191-198,
Mar. 1959.

The surface oxidation kinetics of metallographically polished nickel-cobalt alloys, 10.5 and 25.1% cobalt, have been studied in the temperature range 400° to 800°C using a vacuum microbalance technique. The alloy of largest cobalt concentration oxidized most rapidly. The oxidation rates have been represented, to a first approximation, by cubic and parabolic time laws. In the temperature range of the second order magnetic transformation below the Curie temperature, the Arrhenius temperature coefficients of the rate constants demonstrate continuous variations. It is proposed, with results for nickel oxidation as datum, that these variations are caused by electronic properties of the metal substrate, which influence the rate determining reaction step of metal ion diffusion through the surface oxide layer. (Contractor's abstract)

CAR.08:006

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

OXIDATION OF HAFNIUM, by W. W. Smeltzer and M. T. Simnad. May 15, 1957 [7]p. incl. illus. diagrs. table, refs. (AFOSR-TN-57-243) (AF 18(600)1572) AD 126540

Unclassified

Also published in Acta Metallurgica, v. 5: 328-334,
June 1957.

Hafnium oxidation rates at 760-mm oxygen pressure in the temperature range 350°-1200°C have been represented by logarithmic, parabolic, and linear-rate equations. The respective activation energies for the rate constants were 11.4, 36.0, and 28.1 kcal/mole. The value of the parabolic rate constant was independent of oxygen pressure in the range 10-760 mm. Transformation from parabolic to linear oxidation was caused by formation of a duplex scale of inner compact and outer porous oxides. Monoclinic hafnia was identified as the surface oxide by x-ray examinations; marker measurements showed that oxygen diffused inward through this oxide to react with hafnium at the metal/oxide interface. (Contractor's abstract)

CAR.08:007

Carnegie Inst. of Tech. [Metals Research Lab.]
Pittsburgh, Pa.

NUCLEATION IN THE SOLIDIFICATION OF METALS, by G. M. Pound. [1957] [19]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1572, Office of Naval Research under Nonr-76008, and United Engineering Foundation)

Unclassified

Published in Seminar on Liquid Metals and Solidification, Chicago, Ill. (Nov. 2-8, 1957), Cleveland, Amer. Soc. for Metals, 1958, p. 87-105.

CAR. 08:008-010; CAT. 02:002

Nuclei formation in supercooled liquid metals and nucleation from a vapor phase by using a thermal beam method are described. A theory is presented for the nucleation from the liquid and from the vapor phases which can adequately explain the experimental results in terms of a contact angle between the developing cap-shaped embryo and the substrate surface. It is found that the chemical factors of the substrate surface are less important than the lattice fit with the developing crystal.

CAR.08:008

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

OXIDATION OF METALS, by W. W. Smeltzer and L. H. Everett. June 1, 1958 [7]p. incl. tables, refs. (AFOSR-TN-58-385) (AF 18(600)1572) AD 154292

Unclassified

Also published in *Indust. Engineering Chem.*, v. 50: 496-502, Mar. 1958.

A review article and detailed bibliography on the current theories and experimental results on oxidation of metals and alloys is presented. Tables listing the sources of studies on specific substances or systems are presented for the oxide properties and general thermodynamic properties of metal and alloy systems.

CAR.08:009

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

THE OXIDATION OF IRON IN CARBON DIOXIDE-CARBON MONOXIDE ATMOSPHERES, by W. W. Smeltzer. [1958] [8]p. incl. diagrs. table, refs. (AFOSR-TN-58-725) (AF 18(600)1572) AD 162260

Unclassified

Also published in *Trans. Metall. Soc. AIME*, v. 218: 674-681, Aug. 1960.

The linear formation rates of wustite films have been determined over the temperature range 590° to 1030°C using a vacuum microbalance technique. These rates are dependent directly on the partial pressure of carbon dioxide. Activation energies for film and scale formation in carbon dioxide and oxygen atm are equivalent to either the dissociation energies of carbon dioxide and oxygen, or the activation energy for the diffusion of cation vacancies in wustite. (Contractor's abstract)

CAR.08:010

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

OXIDATION OF AN ALUMINUM-3 PER CENT

MAGNESIUM ALLOY IN THE TEMPERATURE RANGE 200°-550°C, by W. W. Smeltzer. [1958] [5]p. incl. illus. diagrs. tables, refs. (AF 18(600)1572) Unclassified

Published in *Jour. Electrochem. Soc.*, v. 105: 67-71, Feb. 1958.

A study of the oxidation and magnesium evaporation kinetics has been carried out on an aluminum-3% magnesium alloy. A metallographic examination of the surface oxide films produced was included. The alloy was oxidation resistant to 200°C. At temperatures greater than 350°C the oxidation rate was initially inversely proportional to the oxide film thickness, transforming to a constant rate for long exposures. Selective oxidation of magnesium caused formation of aluminum inclusions in the surface oxide. These inclusions imparted a black discoloration to the alloy surface. Magnesium evaporated from the alloy in a vacuum at temperatures greater than 350°C after an induction period, the duration of which was dependent on the temperature. A comparison of the magnesium evaporation and alloy oxidation rates demonstrated that the oxide film offered resistance to oxidation of the metal. (Contractor's abstract)

CAT.02:002

Catholic U. of America. Dept. of Chemistry,
Washington, D. C.

A MOLECULAR ORBITAL STUDY OF Be_4 , by R. D.

Cione and J. S. Dooling. Sept. 1, 1957, 28p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-57-507) (AF 18(600)1537) AD 136588 Unclassified

Also published in *Jour. Chem. Phys.*, v. 29: 425-431, Aug. 1958.

An LCAO MO SCF study was made of the square, planar Be_4 complex. A complete SCF calculation was performed at four different internuclear distances. In this series of calculations all one- and two-center integrals were evaluated exactly and the value of each three- and four-center integral was estimated by a method considered most suitable for it. The results showed the complex unstable. The energy value when extrapolated to infinite internuclear distance were in good agreement with experiment. A second series of calculations was made to determine the effect of three- and four-center integral approximations on the energies. Here all the multicenter integrals were evaluated by one type of approximation. This introduced a relatively small change in the integral values, but large changes in the energies. This study emphasizes the need for exact values of three- and four-center integrals before exact calculations can be undertaken. (Contractor's abstract)

CAT. 03:001; CLH. 01:001;
CDC. 03:001, 002

CAT.03:001

Catholic U. of America. Dept. of Physics,
Washington, D. C.

ON THE DEFINITION OF ENTROPY IN MAGNETIC
RESONANCE, by P. H. E. Meijer. [1957] [8]p. (AF 18-
(603)120) Unclassified

Also published in Proc. Internat'l. Symposium on
Transport Processes in Statistical Mechanics, Brussels
(Belgium) (Aug. 27-31, 1956), N. Y., Interscience
Publishers, Inc., 1956, p. 319-323.

If a system of magnetic spins is dealt with which is
slightly off temperature equilibrium as a result of an
oscillating magnetic field some difficulty has arisen as
to what the correct definition for the entropy would be.
The usual definition does not give the entropy expression
introduced by Wangness. On the other hand his defini-
tion leads to consistent results. It is pointed out that
the application of Casimir's consideration on even and
odd variables leads to a restriction that confirms
Wangness's choice of the definition of entropy. (Con-
tractor's abstract)

CLH.01:001

Cedars of Lebanon Hospital, Los Angeles, Calif.

THE EFFECT OF HEPARIN UPON THE TOTAL OXY-
GEN CONSUMPTION OF ATHEROSCLEROTIC INDI-
VIDUALS, by H. Engelberg. Sept. 21, 1957 [18]p. incl.
tables, refs. (AFOSR-TN-57-632) (AF 18(600)1703)
AD 136617; PB 137462 Unclassified

Total oxygen consumption was measured in athero-
sclerotic individuals before and after heparin, thus elim-
inating the need for determinations of blood flow. Total
basal oxygen consumption and the respiratory quotient
were determined in 46 atherosclerotic patients before
and after the injection of heparin. In 20 individuals
the average increase in oxygen consumption was 32.7%.
In 3, the average decrease was 15.3%. In 23 no change
appeared after heparin. No increase in oxygen consump-
tion appeared after saline placebos or oral anticoagu-
lants. The respiration quotient showed no characteris-
tic change although frequently it fell after heparin.
Various possible mechanisms were discussed which
indicated that the lipemia clearing action of heparin is
responsible for the increase in oxygen consumption.
(Contractor's abstract)

CDC.03:001

Chicago Development Corp., Riverdale, Md.

ELECTRODE POTENTIAL MEASUREMENTS ON
INTERSTITIAL OXYGEN SOLUTIONS IN TITANIUM
AT LOW OXYGEN CONCENTRATIONS. APPLICATION

TO QUALITY CONTROL IN HIGH PURITY TITANIUM, by
R. S. Dean and I. Hornstein. Apr. 1957 [21]p. incl. diagr.
tables, refs. (AFOSR-TN-57-179) (AF 18(600)1458)
AD 126474 Unclassified

A method was developed for determining the O content
in sponge Ti having an O content below 0.06%. EMF
measurements of Ti-O alloys in molten salt electrolytes
up to 1200°C were made in a circular furnace, 12 in. in
diameter and 9 in. high. The outer shell of the furnace
is made from welded steel, and the heating element is a
heavy Nichrome V helical unit. The measurements are
made in an argon atmosphere. The EMF generated be-
tween the standard reference electrode and the Ti-O un-
known is recorded. The electrodes are kept in vibration
while readings are taken to minimize concentration
polarization. The standard electrode should be a care-
fully analyzed Ti rod about 1/4 in. in diameter; about 4 in.
of the rod may be welded to an ordinary Ti rod. The un-
known electrode may be prepared in the same manner as
the standard, or it may be a 15-in.-long iron rod the
bottom 2 in. of which has been drilled out and the thin
sidewalls perforated with 0.1-in. holes about 1/4 in.
apart to form a basket into which particles of the material
to be measured are placed. The bottom of the basket is
then capped. The standard electrode is kept in the molten
electrolyte while the measurements are made. The un-
known is allowed to come to thermal equilibrium before
any EMF readings are taken. The EMF is measured over
a period of several minutes to obtain a steady state value.
At O contents approaching 0.001%, the EMF of a Ti elec-
trode vs the standard 0.06% O was -56 mv as established
by an extrapolated curve of the logarithmic relationship
of EMF as a function of O content. (ASFA abstract)

CDC.03:002

Chicago Development Corp., Riverdale, Md.

TITANIUM METALLURGY. PART I. REDUCTION OF
TITANIUM CHLORIDE BY SOLUTIONS OF ALKALINOUS
METALS IN THEIR FUSED CHLORIDES, by R. S. Dean,
W. W. Gullett and others. [1957] [14]p. incl. diagr.
tables, refs. [AF 18(600)1458] Unclassified

Also published in Industrial Labs., v. 8: 4-7, Apr. 1957.

The coarse crystalline deposits of titanium are produced
by reacting titanium chloride solutions in fused alkaline
chlorides with solutions of alkaline metals in their
fused chlorides. The electrolytic production of pure
coarse crystals of titanium is accomplished by forming
titanium chloride by anodic solution and bringing the so-
lution of such titanium chloride together with the solution
of alkaline metal formed at the cathode at the rate at
which titanium is formed. (Contractor's abstract)

CDC.03:003 - CDC.03:007

CDC.03:003

Chicago Development Corp., Riverdale, Md.

THE DEVELOPMENT OF ELECTROLYTIC TITANIUM PROCESSES, by R. S. Dean. [1957] 8p. incl. refs. [AF 18(600)1458] Unclassified

Presented at meeting of the Electrochem. Soc., Washington, D. C., May 1957.

A description is given for the production of Ti in an electrolytic cell by (1) the deposition of the metal on the cathode by direct or indirect discharge of ions which contain Ti, and (2) deposition by a chemical reaction of a solution of alkaline metal formed at the cathode with Ti salts dissolved in the electrolyte. Two subgroup processes involving Cl and F melts are described for the first process and two subgroup processes of the second method, which are chiefly forwarded by the contractor, are presented and documented by references and patent application references.

Also published in Industrial Labs., v. 8: 93-95, June 1957.

The analysis of fused salts containing titanium chlorides and alkaline metals is described and the significance of the results discussed.

CDC.03:006

Chicago Development Corp., Riverdale, Md.

ELECTRODE POTENTIAL MEASUREMENTS USING INTERSTITIAL OXYGEN SOLUTIONS IN TITANIUM. SODIUM DISSOLVED IN FUSED SODIUM CHLORIDE CONTAINING TITANIUM CHLORIDE, by I. Hornstein. Jan. 1958 [19]p. incl. diagrs. tables. (Rept. no. 2) (AFOSR-TN-58-89) (AF 18(600)1458) AD 148139; PB 134892 Unclassified

Electrode potential measurements were made at 1000°C in an Ar atmosphere between a standard Ti reference electrode and an inert (iron) electrode suspended in a porous TiO₂ tube. The electrode potential was a linear function of concentration and had a negative slope; the results support the assumption that Na dissolved in NaCl electrolyte has an activity which is a negative exponential function of the Na concentration. The partitioning of Na between molten NaCl and molten Pb was studied by heating the samples in a stainless steel bomb at 1000°C for 1 hr. The Na concentration in an electrolyte of NaCl, TiCl₃ as determined by the electrode

potential measurements was in good agreement with that obtained by lead extraction. Partition coefficients which were calculated from equilibrium data varied with the free Na concentration in NaCl, indicating that elemental Na associates into colloidal particles. The partitioning technique was applied to a study of the composition changes which occur when equilibrium conditions in an electrolyte containing Ti, Na, and Cl are disturbed by the extraction of free Na with Pb. The data indicated that within a narrow range of free Na concentration, the soluble Ti, as well as the average valence of the soluble Ti, will remain constant. However, when the free Na concentration is sufficiently lowered by extraction into the Pb phase, TiCl₃ apparently forms TiCl₃ and free Ti; this reaction lowers the soluble Ti concentration with an increase in the average valence.

CDC.03:004

Chicago Development Corp., Riverdale, Md.

TITANIUM METALLURGY. PART II. THE STRUCTURE OF TITANIUM DEPOSITS FORMED IN ELECTROLYTIC CELLS USING FUSED ALKALI CHLORIDE BATHS, by R. S. Dean, W. W. Gullett, and F. A. McCawley. [1957] [14]p. incl. diagrs. [AF 18(600)1458] Unclassified

Also published in Industrial Labs., v. 8: 10-13, May 1957.

Titanium deposits of practical value formed in electrolytic cells using fused alkali chloride baths consist of a titanium plate on the cathode containing alkali metal, a layer of titanium crystals dispersed in salt formed by solution of alkali metal diffusing from the cathode through the titanium depleted zone formed by the plating, and finally crystallization of coarse titanium from the supersaturated solution of alkali metal formed by bringing the anode and cathode products together in a reaction zone free from undissolved alkaline metal and at the rate the titanium crystals separate. (Contractor's abstract)

CDC.03:005

Chicago Development Corp., Riverdale, Md.

TITANIUM METALLURGY. PART III. THE CHEMISTRY OF THE REDUCTION OF TITANIUM CHLORIDE IN FUSED ALKALINE CHLORIDE BY SOLUTIONS OF ALKALINE METALS, by R. S. Dean, L. D. Resnik, and I. Hornstein. [1957] [10]p. incl. diagr. table. [AF 18(600)1458] Unclassified

CDC.03:007

Chicago Development Corp., Riverdale, Md.

RESEARCH ON INTERSTITIAL SOLUTES IN METALS, by R. S. Dean and I. Hornstein. Final rept. Aug. 1958, 1v. incl. diagrs. tables, refs. (AFOSR-TR-58-127) (AF 18(600)1458) AD 203382; PB 136737 Unclassified

Raney observed that titanium containing oxygen dissolved

CHI.16:001, 002; CHI.03:009

anodically to form Ti^{2+} and TiO_2 . Since this reaction involved the change of oxygen in solid solution to TiO_2 , its free energy would be a measure of the activity of the oxygen in solid solution. The careful electrochemical measurements reported confirm and quantify this conclusion. The refining processes of the Chicago Development Corp. for zirconium and chromium included anodic refining analogous to the anode refining reaction for titanium. Measurements of electrode potentials of zirconium-oxygen and titanium-oxygen confirmed and quantified the mechanism of these anodic reactions. The known behavior of alloying elements in titanium alloy refining, in the Chicago Development titanium refining process, was rationalized by electrode potential measurements on the more important of such alloys in the refining bath of the Chicago Development process. The basic condition of the Chicago Development refining process for titanium, zirconium, chromium, etc., has been stated to be the presence of dissolved sodium in the electrolyte - a condition which requires an unusual activity for the dissolved sodium. Electrode potential measurements reported herein have been effective in determining sodium concentration in such electrolytes. The relationship of oxygen content to electrode potential has been shown to be useful as a control method for oxygen in titanium alloys, and to determine the diffusion of oxygen into titanium on heat treatment under various conditions. (Contractor's abstract)

CHI.16:001

Chicago U., Ill.

SOME ULTRAVIOLET MICROSPPECTROPHOTOMETRIC MEASUREMENTS ON ISOLATED NERVE AXONS, by D. A. Eggen. Mar. 1957, 25p. diagrs. (AFOSR-TN-57-171) (AF 18(600)1482) AD 126465 Unclassified

Precise measurements of the ultraviolet extinction have been obtained for single axons isolated from lobster, shore crab (*Carcinus*), crayfish, and frog nerve. The shape of the absorption curves obtained for these axons indicates the presence of several chromophores but the individual bands cannot be clearly resolved. In the axons of the marine invertebrates an intense absorption due to homarine masks the absorption due to other components. In the other axons there is an indication of absorption bands due to protein and to the purine and pyrimidine chromophores of nucleic acid and ATP. There is also an indication of other bands at 250 and 290 mμ and it is suggested that these bands are due to the presence of a protein rich in basic amino acids which may play a significant role in the production of the action response. During the deterioration of the invertebrate axons, characteristic changes have been observed in both the absorption and scattering fractions of the measured extinctions. The changes in absorption are probably due to a loss, through the axon membrane, of some of the absorbing constituents. The changes in scattering probably result from changes in the macromolecular

changes in the ultraviolet extinction in isolated axons which might result from stimulation. Although the data are not yet conclusive, there is an indication of a decrease in extinction (which may be wavelength specific) when the non-myelinated axon is subjected to a tetanic stimulus. An increase in the extinction at 265 mμ which has been reported to occur during the action response in frog axons has not been observed here. (Contractor's abstract)

CHI.16:002

Chicago U., Ill.

ACTION POTENTIAL IN NERVE RESEARCH, by R. J. Moon. Quarterly progress rept. May 1-Oct. 31, 1957. Nov. 1, 1957 [3]p. (AFOSR-TN-58-13) (AF 18-(600)1482) AD 130541 Unclassified

Experimental studies were continued on axons from lobster, frog, and crayfish. Better methods of mounting axons, better preparations of axons, and better techniques in microphotography were developed and used. Work was continued on the assembly and development of the instrumentation needed to extend experimentation into the infrared region of the spectrum.

CHI.03:009

Chicago U. Chicago Midway Labs., Ill.

INDIRECT TRANSITIONS AT THE CENTER OF THE BRILLOUIN ZONE WITH APPLICATION TO InSb, AND A POSSIBLE NEW EFFECT, by W. P. Dumke. [1957] [22]p. incl. illus. diagrs. refs. (AFOSR-TN-57-489) (AF 18(603)9) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 185, Apr. 25, 1957.

Also published in Phys. Rev., v. 108: 1410-1425, Dec. 15, 1957.

The theory of indirect optical transitions is extended to the case where both the valence and the conduction band extrema occur at the center of the Brillouin zone. For this band structure, the dominant electron transition involves a virtual optical transition to a conduction band state, accompanied by scattering to a real state in the conduction band by absorption of a long-wavelength optical mode phonon. An analogous transition may also occur for holes. It is likely that the hole transition will be dominant over the electron transition when the curvature of the conduction band is greater than that of the valence band. It is shown that the absorption edge data on InSb are in agreement with this theory. The experimental evidence on InSb is reviewed and found to be consistent

CHI.03:010 - CHI.03:013

with degenerate valence bands at the center of the Brillouin zone. The absence of any evidence of indirect transitions involving acoustic modes tends to indicate that the shift of the valence maximum away from $k = 0$ due to spin-orbit energy terms is small. A new effect is predicted involving the modulation of the indirect absorption constant by the selective excitation of the long-wavelength optical modes. A simplified theory of this effect is presented and the experimental possibilities of observing it in InSb are discussed. Its existence would verify the proposed indirect transition process as well as indicate the position of the band extrema. (Contractor's abstract)

CHI.03:010

Chicago U. Chicago Midway Labs., Ill.

DEPENDENCE OF LIFETIME AND MOBILITY ON ACCEPTOR CONCENTRATION IN p-TYPE InSb AT 300°K (Abstract), by A. E. Attard and R. N. Zitter. [1957] 1p. (AF 18(603)9) Unclassified

Presented at meeting of the Amer. Phys. Soc., Notre Dame U., South Bend, Ind., June 20-22, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 266, June 20, 1957.

Measurements of PEM and Hall effects and of magnetoresistances have been made on a number of uncompensated p-type InSb samples at 300°K. The general behavior of the observed effects were in agreement with the relations derived in a previous report, so that consistent values of carrier lifetimes and electron and hole mobilities were obtained. Acceptor concentrations of the samples used range from 10^{15} to 10^{18} cm $^{-3}$ (as determined at 77°K). It is found that μ_n varies as $N_a^{-\alpha}$ and μ_p varies as $N_a^{-\beta}$, with $\alpha \approx 1/5$ and $\beta \approx 1/8$. From theoretical considerations, it is expected that direct radiative recombination lifetimes will not be observed in nondegenerate InSb. The result of the present measurements is that the small values of carrier lifetimes ($< 5 \times 10^{-8}$ sec) and the dependence of lifetimes on acceptor concentration in the range $10^{15} - 10^{17}$ cm $^{-3}$ indicate that recombination takes place by a process other than direct radiative recombination. The effects of compensation will be discussed and comparison with lifetimes measurements recently made elsewhere will be evaluated.

CHI.03:011

Chicago U. Chicago Midway Labs., Ill.

COPPER FOIL TRAP OF IMPROVED FORM, by J. Burns. [1957] 1p. incl. diagr. [AF 18(603)9] Unclassified

Published in Rev. Scient. Instruments, v. 28: 469, June 1957.

Thin copper sheets have been introduced in liquid nitrogen cold traps of ultrahigh vacuum systems. The copper sheets which were originally conceived as a means to reduce the desorption of gases from the upper regions of the trap have been found to be effective in reducing contamination of the system from backstreaming pump oil. It was found that the pumping speed through one of these traps was about three times greater than through a copper-filled trap of the usual form and size, and that its effectiveness in blocking oil vapor appeared to be about the same. A nickel sheet trap was constructed and produced an 80-fold lower ultimate vacuum than in the case in which no trap was used.

CHI.03:012

Chicago U. Chicago Midway Labs., Ill.

INDIUM ANTIMONIDE PHOTOCONDUCTIVE INFRARED DETECTOR (Abstract), by L. H. DeVaux and A. J. Strauss. Oct. 1957, 1p. (AF 18(603)9) Unclassified

Presented at meeting of the Electrochemical Soc., Buffalo, N. Y., Oct. 7-9, 1957.

A photoconductive infrared detector has been made from single crystal InSb of unusually high resistivity at liquid nitrogen temperature (~ 100 ohm-cm). The detectivity at liquid nitrogen temperature compares favorably with that of InSb p-n junction photovoltaic cells, but decreases markedly at liquid oxygen temperatures. The long wavelength limit is 5.5μ , as in the photovoltaic cells. The cell design is described, and data are presented on performance as a function of wavelength and intensity of incident light, bias current, and chopping frequency.

CHI.03:013

Chicago U. Chicago Midway Labs., Ill.

ELECTRON TRAPPING IN p-TYPE InSb, by R. N. Zitter, A. J. Strauss, and A. E. Attard. Dec. 10, 1957 [6]p. incl. diagr. (AF 18(603)9) Unclassified

Carrier lifetimes as derived from photoconductive (PC) and photoelectromagnetic (PEM) measurements in p-type InSb indicate that the former lifetimes are larger than the latter rather than equal as expected from the direct recombination model. This model has been altered to include trapping in discrete levels in the forbidden band. The experimental differences in the lifetimes and the behavior of the temperature variation of the PC lifetimes have generally been accounted for by the altered model.

CHI.03:014 - CHI.03:017

CHI.03:014

Chicago U. Chicago Midway Labs., Ill.

PREPARATION AND PROPERTIES OF INDIUM ARSE-NIDE, by R. H. Harada and A. J. Strauss. July 31, 1958, 24p. incl. illus. diagrs. refs. (Rept. no. CML-TN-P108-14) (AFOSR-TN-58-742) (AF 18(603)9) AD 202311; PB 137689 Unclassified

Also published in Jour. Appl. Phys., v. 30: 121, Jan. 1959.

Arsenic prepared by reduction of arsenic trichloride and purified by a thermal gradient sublimation technique has been used to prepare zone-refined n-type InAs as pure as any previously reported, although its free carrier concentration is still somewhat greater than 10^{16} cm^{-3} . A horizontal modification of the Bridgman technique has been used to grow large single crystals of InAs. The results of electrical measurements on the n-type material are in good agreement with those obtained elsewhere. These results, together with the results of heat treatment experiments performed at the Naval Ordnance Lab., support the view that the free carriers in the InAs are produced by ionization of donor impurities (principally sulfur) which originate in the arsenic used for synthesis. Compensated samples of InAs have been prepared by doping with cadmium. One such sample exhibits anomalous electrical properties similar to those reported in the literature for samples doped with zinc. Another cadmium-doped sample has a resistivity of 80 ohm-cm at 77°K, by far the highest value ever reported for InAs. (Contractor's abstract)

CHI.03:015

Chicago U. Chicago Midway Labs., Ill.

THE CHanneled, SHAPed-SCREEN IMAGE INTENSIFIER, by J. Burns and M. J. Neumann. July 31, 1958, 17p. incl. illus. diagrs. (Rept. no. CML-TN-P108-16) (AFOSR-TN-58-756) (AF 18(603)9) AD 202312 Unclassified

The present status of the channeled, shaped-screen intensifier may be summarized as follows: the principle offers certain characteristic advantages over other types of intensifiers, the chief ones being resolution independent of the number of stages, low voltage operation with the attendant possibility that background levels will be low, and the possibility, depending on design requirements of the photocathode, that the screens can be made to support the atmospheric pressure on thin face-plates, making the construction of large-area tubes a possibility. Thus far a dynode design has been devised which has yielded gains per stage equal to about 75% of the secondary emission ratio of the dynode surface at a design voltage of 400 volts per stage on a five-stage tube having 25-mesh dynodes. It appears that the prob-

lem of finding a suitable interscreen insulation for finer mesh dynodes can be solved by the use of glass enamel; however, it remains to be seen whether this kind of insulation causes any noise or background difficulties. The problem of making fine mesh screens of the proper shape also appears well on its way toward a successful solution. The production of uniform, stable, high-yield secondary emission surfaces on these screens by evaporation of thin films of Mg followed by oxidation is progressing, but has not reached the desired state of reproducibility at this writing. The design of the photocathode and first dynode is still at an early stage, but two designs have been evolved which seem to merit closer study. The successive reduction in scale of the multiplier has reached the 50 to 65-mesh level. The background level and noise characteristics of the multiplier have not yet been measured, but series of tubes in the 50 to 65-mesh scale presently under construction should provide a good indication as to what may be expected in this respect in still smaller-scale multipliers. (Contractor's abstract)

CHI.03:016

Chicago U. Chicago Midway Labs., Ill.

SEMICONDUCTORS AND PHYSICAL ELECTRONICS, by F. F. Rieke. Final rept. June 30, 1958, 15p. incl. table, refs. (Rept. no. CML-TR-P108-18) (AFOSR-TR-58-137) (AF 18(603)9) AD 204556 Unclassified

A review of the accomplishments and a catalog of the reports, journal articles, talks at symposia and scientific meetings, published abstracts and résumés are listed under the following headings: (1) Semiconductors (Preparation of Pure Single Crystals and Research); (2) Research on Secondary Electron Emission; (3) Image Amplifier; (4) Thermal Image Tube; (5) Infrared Detectors; and (6) Titanates and Pyroelectric Thermal Detectors.

CHI.03:017

Chicago U. Chicago Midway Labs., Ill.

SOME FEATURES OF THE ANGULAR DISTRIBUTION OF SECONDARIES FROM METAL SINGLE CRYSTALS (Abstract), by J. Burns. [Feb. 1958] 1p. (AF 18(603)9) Unclassified

Presented at the Colloquium of Secondary Emission, Minnesota U., Minneapolis, Feb. 27-28, 1958.

Measurements of the angular distributions of secondaries in several energy ranges have been made on (100) faces of copper and nickel crystals and on the (112) face of a tungsten crystal. The measurements cover a range of primary energies from 200 to 1000 eV at several angles of incidence. Data were obtained on surfaces cleaned by slow ion bombardment, followed by annealing, and on gas-covered surfaces. The main qualitative

CHL03:018 - CHL03:022

features of these angular distributions are discussed with special reference to fine structure and deviations from a cosine distribution in relation to crystal orientation.

CHL03:018

Chicago U. Chicago Midway Labs., Ill.

CARRIER RECOMBINATION IN p-TYPE InSb (Abstract), by A. J. Strauss and A. E. Attard. [1958] 1p. (AF 18(603)9) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago U., Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 120, Mar. 27, 1958.

The photoconductive (PC) and photoelectromagnetic (PEM) effects in p-type InSb have been studied in detail as functions of free hole concentration at 77°K, and for several concentrations photoconductivity has been investigated as a function of temperature between 77° and 300°K. At 77°K, it is found that the PEM lifetime, τ_{PEM} , is approximately 2×10^{-10} sec, independent of hole concentration, while $\tau_{PC} = (3 \times 10^7)/p_0$ sec, where p_0 is expressed in cm^{-3} . The fact that τ_{PC} is greater than τ_{PEM} for sufficiently pure samples indicates that excess electrons are trapped in bound states in the forbidden gap, with the ratio of trapped to free electrons equal to $(5 \times 10^{18})/p_0$. Electron trapping is also indicated by the results of quenching experiments with dc light. The data for temperatures below 200°K will be interpreted in terms of a Shockley-Read recombination mechanism; at higher temperatures, direct interband recombination mechanism (probably of the Auger type) appears to predominate.

CHL03:019

Chicago U. Chicago Midway Labs., Ill.

SEGREGATION CONSTANTS AND CARRIER MOBILITIES IN InSb (Abstract), by A. J. Strauss. [1958] 1p. (AF 18(603)9) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago U., Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 119, Mar. 27, 1958.

The following distribution coefficients have been measured for InSb crystals pulled from the melt at an extraction rate of 1.3 cm/hr and rotation rate of 130 rpm:

Cd, 0.26; Zn, 3.38; Se, 0.17; Te, 0.54. The distribution coefficient for zinc has been found to vary with extraction and rotation rates in the manner predicted by the theory of Burton, Prim, and Slichter. Hall mobilities at 77°K have been measured for uncompensated samples containing impurity concentrations between 10^{15} and 10^{19} cm^{-3} . Mobilities calculated from scattering theory are in moderately good agreement with the experimental values for n-type samples, but the agreement is considerably less satisfactory for p-type samples.

CHL03:020

Chicago U. Chicago Midway Labs., Ill.

RECOMBINATION OF CARRIERS IN InSb, by R. N. Zitter, A. J. Strauss, and A. E. Attard. [1958] 4p. (AF 18(603)9) Unclassified

Presented at the Electrochemical Soc. Semiconductor Symposium, New York, Apr. 1958.

Recombination of excess carriers in n- and p-type InSb below 200°K is shown to take place primarily via bound states in the forbidden gap. The activation energies, concentrations and recombination parameters associated with these states are estimated from measurements of the dependence of photoconductive and photoelectromagnetic lifetimes on temperature, impurity concentration and light intensity.

CHL03:021

Chicago U. Chicago Midway Labs., Ill.

INTEUM ANTIMONIDE INFRARED FILTER, by J. M. Powell and S. W. Kurnick. [1958] 2p. incl. diagrs. (AF 18(603)9) Unclassified

Published in Jour. Appl. Phys., v. 29: 1129-1130, July 1958.

N-type single crystal InSb of about 10^{17} donors cm^{-3} may be used as an infrared filter around room temperature. The transparency of this material is further increased by means of an anti-reflection coating of As_2S_3 . At 25°C the maximum transmission which occurs at 9 microns is increased from about 27% for no coating to about 55% with the anti-reflection coating, while at 0°C the maximum transmission rises to 60%.

CHL03:022

Chicago U. Chicago Midway Labs., Ill.

DISTRIBUTION COEFFICIENTS AND CARRIER MOBILITIES IN InSb, by A. J. Strauss. Sept. 12, 1958,

CHL 03:023, 024; CHL 04:003, 004

14p. incl. diagrs. tables, refs. (AF 18(603)9)
Unclassified

Also published in Jour. Appl. Phys., v. 30: 559-563,
Apr. 1959.

The following distribution coefficients have been measured for InSb crystals pulled from the melt at an extraction rate of 1.3 cm/hr and rotation rate of 130 rpm: Cd, 0.26; Zn, 3.38; Se, 0.17; and Te, 0.54. The distribution coefficient for zinc has been found to vary extraction and rotation rates in the manner predicted by the theory of Burton, Prim, and Slichter. Hall mobilities at 77°K have been measured for uncompensated samples containing impurity concentrations between 10^{15} and 10^{19} cm⁻³. Mobilities calculated from scattering theory are in moderately good agreement with the experimental values for n-type samples, but the agreement is considerably less satisfactory for p-type samples. (Contractor's abstract)

CHL03:023

Chicago U. Chicago Midway Labs., Ill.

PIEZORESISTANCE CONSTANTS OF n-TYPE InAs,
by A. J. Tuzzolino [1958] 1p. incl. table, refs.
(AF 18(603)9) Unclassified

Published in Phys. Rev., v. 112: 30, Oct. 1, 1958.

A measurement of the piezoresistance constants of single crystal specimens of n-type InAs as a function of temperature from 77° to 300°K has been made. It is concluded that the results of this experiment are consistent with a spherical conduction band model for InAs.

CHL03:024

Chicago U. Chicago Midway Labs., Ill.

THE ROLE OF TRAPS IN THE PHOTOELECTRO-
MAGNETIC AND PHOTOCONDUCTIVE EFFECTS,
by R. N. Zitter. [1958] 4p. incl. refs. (AF 18(603)9)
Unclassified

Published in Phys. Rev., v. 112: 852-855, Nov. 1, 1958.

When carriers recombine through traps, the excess concentrations of mobile electrons and holes are not necessarily characterized by a single lifetime τ . Under the assumption that electrons and holes have separate lifetimes which in general are different, expressions for the steady-state PEM and PC currents are obtained which show that in certain cases the PEM current is determined by a lifetime different from the one determining the PC current. The results of the PEM-PC measurements can be used to evaluate the

parameters of any particular model which might be postulated for the recombination process. However, the theoretical treatment of the PEM-PC effects presented here is independent of such models and so can be used as a method for testing their validity. (Contractor's abstract)

CHL04:003

Chicago U. Committee on Math. Biology, Ill.

CONTRIBUTIONS TO THE THEORY OF ACTIVE TRANSPORT. II. THE GATE TYPE NON-CARRIER MECHANISM AND GENERALIZATIONS CONCERNING TRACER FLOW, EFFICIENCY, AND MEASUREMENT OF ENERGY EXPENDITURE, by C. S. Patlak. June 1957 [43]p. incl. diagrs. refs. (AFOSR-TN-57-285) (AF 18(600)-1454) AD 132356
Unclassified

Also published in Bull. Math. Biophys. v. 19: 209-235, Sept. 1957.

The gate type non-carrier mechanism, an active transport model, is discussed. In this mechanism, the actively transported particle passes through the gate itself by means of a series of reorganizations of the active transport mechanism. The net rate of transport, the rate of transport in either direction, and the efficiency of this model are analyzed. It is shown that on the basis of these analyses alone, this mechanism cannot be distinguished from a carrier mechanism. Three generalizations which apply to many individual type active transport models are then discussed. These pertain to (1) the dependency of the flow in one direction on the concentration of the particles on the opposite side of the membrane, (2) the possibility of very high efficiencies for these models independent of the rate of the active transport, and (3) the methods whereby the energy expended in the active transport may be experimentally found. (Contractor's abstract)

CHL04:004

Chicago U. Committee on Math. Biology, Ill.

ON THE INTERPRETATION OF THE EFFECT OF AREA ON THE CRITICAL FLICKER FREQUENCY, by H. D. Landahl. [1957] 6p. incl. diagr. (AFOSR-TN-57-455) (AF 18(600)1454) AD 136446
Unclassified

Also published in Bull. Math. Biophys., v. 19: 157-162, June 1957.

The effects of area and intensity on the critical flicker frequency, threshold, and reaction time are considered in terms of neural net theory. An attempt is made to develop a mechanism which can account for the phenomena associated with the empirically observed laws of Ricco, Granit, Talbot, and Ferry-Porter as well as observations on reaction time threshold. A simple model

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gives results which are substantially in agreement with observation except for a few apparent discrepancies. Experimental procedures are suggested which can determine whether these are apparent or real. (Contractor's abstract)

CHL04:005

Chicago U. Committee on Math. Biology, Ill.

FACTORS IN VISUAL ACUITY. I. NEURAL INHIBITION AND THE VISUAL PERCEPTION OF CONTOURS, by P. H. Greene. [1957] 15p. incl. diagrs. (AFOSR-TN-57-456) (AF 18(600)1454) AD 136447 Unclassified

Also published in Bull. Math. Biophys., v. 19: 147-156, June 1957.

Interpretations of the mechanisms of perception of contours or of Mach bands have stressed either the role of various spatial derivatives of light intensity at the retina or the importance of various forms of inhibitory effects between neighboring retinal elements. Evidence is presented in support of the latter type of interpretation. It is considered that the brightness contrast and perceived contours arise from neural elements, each of which is stimulated in proportion to the intensity of photoreceptor excitation at a point of the retina and inhibited in proportion to the mean intensity in some neighborhood of that point. The role of the spatial derivatives is best seen as a particular manifestation of the inhibitory mechanism. Predictions based upon this hypothesis appear to be consistent with experimentally observed evidence. (Contractor's abstract)

CHL04:006

Chicago U. Committee on Math. Biology, Ill.

FACTORS IN VISUAL ACUITY. II. THE RELATION OF BLURRED RETINAL IMAGES AND NEURAL INHIBITION TO IRRADIATION, by P. H. Greene. [Jan. 13, 1958] 55p. incl. diagrs. refs. (AFOSR-TN-58-26) (AF 18(600)1454) AD 148065 Unclassified

It is known that the mode of variation of the apparent width of a bar with variation of its luminance depends upon the objective width of the bar. Common interpretations of this phenomenon are discussed and summarized. These interpretations refer to characteristics of the sloping retinal excitation distribution which results from the blurring, or "diffusion," of the luminance distribution of the bar. On the assumption that a Gaussian distribution results from the diffusion of an infinitely narrow bar, the blurred excitation distribution arising from a wider bar is calculated. Making use of this calculation, it is shown that none of the proposed interpretations of irradiation would explain its observed dependence upon the width of the bar unless the standard deviation of the Gaussian diffusion function exceeded

1'35", which is more than twice the standard deviation calculated on the basis of optical effects and threshold measurements. It is concluded that the larger standard deviation takes into account the further diffusion of the excitation distribution in the network of neurons responsible for determining the location of the contour. (Contractor's abstract)

CHL04:007

Chicago U. Committee on Math. Biology, Ill.

REPRESENTATION OF MODALITY IN CUTANEOUS SENSIBILITY, by H. D. Landahl and C. M. Williams. [1958] 9p. incl. diagrs. (AFOSR-TN-58-313) (AF 18(600)1454) AD 154217 Unclassified

Also published in Bull. Math. Biophys., v. 20: 309-315, Dec. 1958.

Morphologically identical nerve endings subserve more than one sensory modality. Two possible explanations are: such endings are functionally different, responding to one type of physical excitation only, or such endings are capable of responding to more than one type of physical stimulus, but central mechanisms discriminate between different stimuli. A simple network is described to illustrate how thermal receptors could discriminate between thermal and mechanical stimuli. (Contractor's abstract)

CHL04:008

Chicago U. Committee on Math. Biology, Ill.

ON THE BIOPHYSICS OF VISION, by S. Kamiya. [1958] 45p. incl. diagrs. refs. (AFOSR-TN-58-343) (AF 18(600)1454) AD 154248 Unclassified

Also published in Bull. Math. Biophys., v. 20: 343-373, Dec. 1958.

A photochemical system is considered which is similar to that of S. Hecht but which includes an intermediate substance between visual purple and visual white. This intermediate is assumed to change the membrane voltage of the photoreceptors. A simple method is presented from which one may calculate the frequency of the impulses resulting from the application of light. It is found that this physicochemical model enables one to account for a considerable number of physiological phenomena of vision. Among these are the light and dark adaptation phenomena. By introducing a simple assumption regarding spatial interaction one can account for some psychological phenomena such as the effect of intensity, a light-dark ratio, shape, and area on the critical flicker frequency. A number of other phenomena are discussed in terms of the model. (Contractor's abstract)

CHL 04:009, 010; CHL 17:001;
CHL 06:009

CHL 04:009

Chicago U. Committee on Math. Biology, Ill.

A MATHEMATICAL INTERPRETATION OF MOTOR REACTIONS TO FIXED AND MOVING STIMULATION OF THE EYE, by M. Valentiniuzzi. [June 1958] [34]p. incl. diagrs. refs. (AFOSR-TN-58-697) (AF 18(600)-1454) AD 162231; PB 137896 Unclassified

Also published in Bull. Math. Biophys., v. 21: 327-341, Dec. 1959.

The results of experiments performed by L. S. Stone and by R. W. Sperry on vision in salamanders are analyzed. A summary of Reichardt's theory, which originated in the researches of B. Hassenstein on insects, is given, and an application to salamanders is carried out. Introducing a simpler mathematical development based on the one-factor theory of excitation, the same formal results are obtained. A complete model, which includes those results and tries to fit the salamander behavior described by Stone, is elaborated and translated into Boolean terms. As a complementary consideration, it is pointed out that the functional rigidity of the visuomotor system, deriving from a biological molecular hysteresis, could be framed in the neuro-affinity principle, the spatial expression of which would turn out to be a biological field. (Contractor's abstract)

CHL 04:010

Chicago U. Committee on Math. Biology, Ill.

FACTORS IN VISUAL ACUITY, by P. H. Greene. Aug. 25, 1958, 1v. incl. diagrs. refs. (AFOSR-TR-58-85) (AF 18(600)1454; continued by AF 49(638)414) AD 236778 Unclassified

An interpretation is suggested for experimental results on the location of perceived contours in studies of Mach bands (sharply defined subjective bands seen in continuous luminance distributions), irradiation (change in apparent width of a bar with changes in luminance), and resolution distance (minimum distance separating two bars which can just be perceived as separate). An experiment based upon analysis of the Mach band experiments supports the view that contour-perception depends upon inhibitory influences between neighboring points in the visual pathway. Analysis of the irradiation experiments shows that the spatial extent of the blurring of the visual image owing to optical and neural effects must be at least twice the amount in the literature for the optical part of the blurring. Experimental results may be consistently interpreted by the hypothesis that a contour appears at a point where the difference between the local excitation intensity and the average intensity in a neighborhood of the point attains a threshold, or else at the point of maximum slope of the excitation distribution in case the difference nowhere attains its threshold. Resolution is shown to depend upon two factors: intensity

discrimination and the response of the inhibitory mechanism. The inhibitory mechanism can allow resolution of two bright bands even when they are so close together that their blurred excitation distribution is unimodal. (Contractor's abstract)

CHL 17:001

Chicago U. Committee on Math. Biology, Ill.

A CONTRIBUTION TO THE STUDY OF THE DIFFUSION OF NEUTRAL PARTICLES THROUGH PORES, by C. S. Patlak. Nov. 1958, 12p. incl. diagr. (AFOSR-TN-58-1075) (AF 49(638)414; continuation of AF 18(600)1454) AD 207454 Unclassified

Also published in Bull. Math. Biophys., v. 21: 129-140, June 1959.

Diffusion through a flat pore into a large region is proportional to the linear dimension of the pore and not to its area. This was first explained by Brown and Escombe (1900) for a circular pore and is here generalized, by means of a dimensional argument, to include any type of regular opening. The problem is further generalized to include diffusion through pores of finite thickness, finite distance apart, and into finite regions. Since this problem cannot be solved exactly, an approximation method is introduced. Reasons for the credibility of the approximation are presented. It is then shown, by means of the approximation method, that the diffusive flow through a pore is equal to the total concentration difference divided by the resistance of the system. The resistance, in turn, is the sum of the resistances of all portions of the system, each of which is calculated. The result is compared with results which have been calculated exactly for limiting cases and found to agree very well. The results are then applied to a standard method of computing pore size in membranes, and it is shown that the correction factor is negligible. (Contractor's abstract)

CHL 06:009

Chicago U. [Dept. of Mathematics] Ill.

ON SINGULAR INTEGRALS, by A. Zygmund. [1957] 38p. incl. refs. [AF 18(600)1111] Unclassified

Published in Rend. Matem. e Appl., v. 18: 468-506, 1957.

In former papers (e.g., Acta Math., v. 88: 85-139, 1952; Studia Math., v. 14: 249-271, 1954; Amer. Math., v. 78: 289-306, 1956) A. P. Calderón and A. Zygmund have dealt with the extension of Hilbert's operator to singular integrals in the n -dimensional space E^n ($n \geq 2$); including that for periodic functions, i.e., the conjugate functions operator. The results were applied to potential theory. In the present paper, their main results and some of the proofs are given in a systematic and concise arrangement. (Probably a complete representation of the theory,

CHI.08:004 - CHI.08:007

including the earlier work of other writers on the subject, in book form would be appreciated by mathematicians.) In § 1 the author starts from the classical Riesz theory on Hilbert's operator in E^1 . Then he states the results for the class L^p in E^n and gives examples for $n = 1, 2, 3$. In § 2, various generalizations in E^n are discussed, including transforms of infinite sequences of numbers and conjugate functions. In §§ 3-7 proofs of results are given; an essential tool for some of them is the Fourier transform in E^n . In § 8, application is made to the theory of the tent. A short bibliographical note is added. It refers to the work of the writers who have raised the problem. (Math. Rev. abstract)

CHI.08:004

Chicago U. [Dept. of Mathematics] Ill.

ON UNITARY REPRESENTATIONS OF NILPOTENT LIE GROUPS, by J. Dixmier. 1957 [2]p. (AFOSR-TN-57-506) (AF 18(600)1383) AD 218397 Unclassified

Published in Proc. Nat'l. Acad. Sciences, v. 43: 985-986, Nov. 1957.

Also published in Amer. Jour. Math., v. 81: 160-170, Jan. 1959.

If G is a locally compact separable unimodular group it is known that the regular representation of G may be expressed as a direct integral of factor representations U_χ where the χ run over a measure space Ω supplied with a positive measure μ . Furthermore if f is in $L_1(G) \cap L_2(G)$ and $U_\chi(f)$ is the operator corresponding to f in the representation U_χ , the Plancherel formula states that

$$(*) \int_G |f(x)|^2 dx = \int_\Omega \text{tr}(U_\chi(f) \cdot U_\chi(f)) d\mu(\chi),$$

where dx is Haar measure on G . The following results are stated in the case that G is a simply connected nilpotent Lie group. (1) Ω can be chosen to be the complement of the zeroes of a polynomial in a real q -dimensional Euclidean space. (2) There is a fixed Hilbert space H and for each χ in Ω an irreducible representation U_χ of G on H ; for each f in $L_1(G)$, the Fourier transform of f defined by $U_\chi(f) = \int_G U_\chi(x) f(x) dx$ is strongly continuous and zero at infinity on Ω . (3) There is a positive measure μ on Ω defined by a regular differential form of degree q so that (*) is valid for f in $L_1(G) \cap L_2(G)$. (Math. Rev. abstract)

CHI.08:005

Chicago U. Dept. of Mathematics, Ill.

ON THE ABSTRACT APPROACH TO THE LOCAL THEORY OF CONTINUOUS INFINITE PSEUDO GROUPS, by M. Kuranishi. Oct. 1957, 95p. (AFOSR-TN-57-728) (AF 18(600)1383) AD 136712; PB 133351 Unclassified

An attempt is made to generalize the notion of local Lie groups to the special case of infinite dimensional parameter space so that the generalized notion can be used as parameter groups of continuous infinite pseudo groups of transformations. This involves generalizing the notion of analytic functions and the notion of formal power series. Only the local aspect of the theory is treated, and the discussion is restricted to the analytic case, real or complex. (ASTIA abstract)

CHI.08:006

Chicago U. Dept. of Mathematics, Ill.

FOUNDATIONS OF FIBER BUNDLES. LECTURES, by S. Eilenberg. Summer 1957, 1v. (In cooperation with Columbia U. AF 18(603)87) (AFOSR-TN-57-733) (AF 18(600)1383) AD 136720 Unclassified

Abstract published in Internat'l. Symposium on Algebraic Topology, Mexico City (Aug. 1956) Mexico City, National U. of Mexico, 1958, p. 18-23.

A discussion is presented of categories, functors, and faithful functor. Theory of local categories is given. Some applications mentioned are: manifolds, the category (B, F) bundles, functors of categories of bundles, comparison of (B, F) -bundles, reciprocal structures, categories with products, products of bundles, the category V^X , diagonal maps and separation, compactness and generalized bundles.

CHI.08:007

Chicago U. Dept. of Mathematics, Ill.

SEMINAR IN TOPOLOGY. PARTS I AND II, by S. MacLane. Summer 1957, 2v. inv. refs. (AFOSR-TN-57-769) (AF 18(600)1383) AD 136759 Unclassified

The following research papers on algebraic mechanism of fiber spaces are included. Part I: A Relation Between Homotopy Groups and Cohomology, by J. F. Adams; The Suspension of a Loop Space, by W. D. Barcus and J. P. Meyer; Higher Hopf Invariants, by M. G. Barratt; The Construction and Classification of Semi-simplicial Bundles, by M. G. Barratt, V. K. A. M. Gugenheim, and J. C. Moore; Atomic Homology Structures, by F. W. Bauer; Homology of Prolonged Functors, (Symmetric Products, a.o.), by A. Dold; Regular Mappings and

CHL08:008 - CHL08:010

Dimension, by E. Dyer; and Comological Dimension of Groups, by S. Eilenberg. Part II: On the Structure of Higher Differential Operators in Spectral Sequences, by E. Fadell; Abstract Theory of Pseudogroups, by J. W. Gray; Generalised Manifolds, by H. B. Griffiths; A Geometrical Interpretation of G. Whitehead's Generalisation of H. Hopf's Invariant, by M. A. Kervaire; Homotopy Type Embeddings, by F. P. Peterson; Two Formulas Concerning Secondary Operations, by E. P. Peterson and N. Stein; On Classifying Immersions of S^k in Euclidean Space, by S. Smale; and Homology of Cyclic Products, by R. G. Swan.

CHL08:008

Chicago U. Dept. of Mathematics, Ill.

EXTENSIONS AND OBSTRUCTIONS FOR RINGS, by S. MacLane. [1958] [30]p. incl. refs. (AFOSR-TN-57-776) (AF 18(600)1383) AD 148006 Unclassified

Also published in Illinois Jour. Math., v. 2: 316-345, Sept. 1958.

An extension is defined by an epimorphism of algebras $E \rightarrow A$; when the product of any two elements of the kernel A is 0, the left multiplication (resp. right) by an element of E induced upon A a (A bimodule) structure. The author tries on one side to free himself from the hypothesis according to which the algebras considered have a body basis (in fact, the case of rings, i.e. algebras over \mathbb{Z} , is studied), which introduces obstructions of an additive character besides multiplicative obstructions. The case is also studied where the induced multiplication upon A is not zero. A new definition of the cohomology groups $H^n(A, K)$ with coefficients in a A bimodule K is given. It is proved that if K is a A -bimodule, the extension classes $0 \rightarrow K \rightarrow E \rightarrow A \rightarrow 0$ which define over K , this bimodule structure (the multiplication induced upon K being zero), are in bijective correspondence with $H^2(A, K)$.

CHL08:009

Chicago U. Dept. of Mathematics, Ill.

A PROOF OF THE SUBGROUP THEOREM FOR FREE PRODUCTS, by S. MacLane. Jan. 1958, 12p. (AFOSR-TN-58-69) (AF 18(600)1383) AD 148112 Unclassified

Also published in Mathematika, v. 5: 13-19, June 1958.

Let A_j be a group for each $j \in J$. The free product $G = *_{j \in J} A_j$ is a group generated by the A_j in which any two distinct reduced words represent distinct elements. Take $g \in G$ and $H \leq G$, then the subgroup $H \cap gA_jg^{-1}$ depends,

up to isomorphism, only on the double coset $D = HgA_j$.

A new algebraic proof is given for the following theorem: to any subgroup H of the free product G there exists for each $j \in J$ a set $\{S_j(D)\}$ of representatives of the $H-A_j$ double cosets D such that H is the free product of its subgroups $H = F * [*_{j \in J} (*_{D \in S_j(D)} [H \cap sA_js^{-1}])]$ where F is a free group, $s = S_j(D)$, and j ranges over J and for each j , D ranges over the $H-A_j$ double cosets in G . If the index $G:H$ is finite, the number of free generators of F is $1 - [G:H] + \sum_j ([G:H] - m_j)$ where m_j is the number of $H-A_j$ double cosets in G .

CHL08:010

Chicago U. [Dept. of Mathematics] Ill.

[THE GEOMETRIC REALIZATION OF A TWISTED CARTESIAN PRODUCT] Die geometrische Realisierung eines schiefen kartesischen Produktes, by A. Dold. Sept. 12, 1957 [12]p. (AF 18(600)1383) AD 148141 Unclassified

Also published in Arch. der Math., v. 9: 275-286, 1958.

Intuitively a twisted Cartesian product of two semi-simplicial complexes F and B is almost a fibre space with projection map $\pi: E \rightarrow B$ and fibre F , where E is the total complex of the twisted Cartesian product. In this paper the author proves three main theorems. Theorem 1: Let (F, B, E) be a twisted Cartesian product which has a structural monoid complex H , such that $\pi_0(H)$ (the path components of H) form a group; then the geometric realization of the map $\pi: E \rightarrow B$ is a quasi-fibration, with total space the geometric realization of E , base the realization of B , and fibre the realization of F . Theorem 2: Let K be a semi-simplicial complex with base point, A a subcomplex with the same base point, and K/A the complex obtained by collapsing A to a point. Let $SP(K)$, $SP(K/A)$, and $SP(A)$ denote the infinite symmetric products of the complexes K , K/A , and A . Under these conditions there exists a twisted Cartesian product $(SP(A), SP(K/A), SP(K))$ with fibre $SP(A)$, base $SP(K/A)$, and total complex $SP(K)$. This twisted Cartesian product is principal with structural monoid $SP(A)$. Theorem 3: If Γ is an associative H -space with unit such that $\pi_0(\Gamma)$ is a group, then Γ has the same weak homotopy type as the space of loops in a connected space. The first of these theorems shows that one's intuition is correct: a twisted Cartesian product is almost a fibre space. The second is useful in abstracting the earlier work of the author and R. Thom on infinite symmetric products in the geometric case [A. Dold and R. Thom, Ann. of Math. v. 67: 239-281, 1958] to the semi-simplicial case. The third theorem is a further application of the first theorem. (Math. Rev. abstract)

CHL 08:011; CHL 18:001-003;
CHL 19:001; CHL 10:007

CHL 08:011

Chicago U. Dept. of Mathematics, Ill.

PRINCIPAL QUASIFIBRATIONS AND FIBRE
HOMOTOPY EQUIVALENCE OF BUNDLES, by A. Dold
and R. Lashof. Feb. 1958 [21]p. (AFOSR-TN-58-180)
(AF 18(600)1383) AD 152213 Unclassified

Also published in Illinois Jour. Math., v. 3: 285-305,
June 1959.

Let H be a topological space with a continuous multi-
plication which is associative and has a 2-sided unit.
In analogy to the case of a topological group, the authors
construct in this paper a universal quasi-fibration
with fibre H . As an application, they obtain a classifi-
cation of fibre bundles with respect to fibre homotopy
equivalence. (Math. Rev. abstract)

CHL 18:001

Chicago U. Dept. of Mathematics, Ill.

RESEARCH ON BANACH ALGEBRAS, by I. Kaplansky.
Final rept. Feb. 1-Sept. 30, 1957, 1p. (AFOSR-TR-
57-89) (AF 18(600)1478) AD 136697 Unclassified

Some questions were studied concerning projective
modules which are the basic tool in the new field of
homological algebra. A result obtained in this connec-
tion is the following: if M is a direct sum of (any number
of) countably generated modules, then the same is true
for any direct summand of M . This has a number of
corollaries. One is that any projective module over a
local ring is free. Another is the completion of a
problem posed by Baer: if a torsion-free abelian group
 G is a direct sum of groups of rank one, then the same
is true for any direct summand of G . Lie algebras
were also dealt with. (Contractor's abstract, modified)

CHL 18:002

Chicago U. Dept. of Mathematics, Ill.

ON THE DIMENSION OF MODULES AND ALGEBRAS.
A RIGHT HEREDITARY RING WHICH IS NOT LEFT
HEREDITARY, by I. Kaplansky. [1958] [4]p. [AF 18-
(600)1478] Unclassified

Published in Nagoya Math. Jour., v. 13: 85-88, June
1958.

A ring R is right [left] hereditary if every right [left]
ideal in R is projective. The author shows that a ring
may be right hereditary but not left hereditary by proving
the following theorem: Let V be a vector space of count-
ably infinite dimension over a field F . Let C be the
algebra of all linear transformations on V with finite-
dimensional range. Let B be the algebra obtained by

adjoining a unit element to C and let $A = B \otimes_F B$. Then
 A is right hereditary but not left hereditary. The proof
proceeds by showing that A is a regular ring (i.e., for
any a there is an x such that $axa = a$); that in a regular
ring every countably generated (right) ideal is projective;
and that in A every right ideal is countably generated.
Thus A is right hereditary. The author then produces
a (non-countably generated) left ideal which is not pro-
jective. (Math. Rev. abstract)

CHL 18:003

Chicago U. [Dept. of Mathematics] Ill.

LIE ALGEBRAS OF CHARACTERISTIC p , by I.
Kaplansky. 1958 [35]p. [AF 18(600)1478] Unclassified

Published in Trans. Amer. Math. Soc., v. 89: 149-183,
Sept. 1958.

The problem is attacked here, with considerable success
of classifying all simple Lie algebras, over an arbitrary
algebraically closed field, possessing Cartan subalgebras
of dimensions 1 and 2.

CHL 19:001

Chicago U. Dept. of Mathematics, Ill.

RESEARCH FOR NEW TYPES OF NUMBER-
THEORETICAL SYSTEMS, by A. Wall. Final technical
rept. July 1958, 14p. (AFOSR-TR-58-103) (AF 18-
(603)57) AD 162245 Unclassified

This report gives a presentation of the work conducted
under this contract on the following subjects: (1) the
classical problem of the moduli of algebraic curves
over complex numbers; (2) the study of the Kähler
varieties topologically identical with non-singular
quartics in projective 3-space (hence forward called
K3 surfaces).

CHL 10:007

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

THE RADIATION AGE OF A METEORITE FROM
COSMIC RAY PRODUCED He^3 AND H^3 , by F.
Bogemann, J. Geiss, and D. C. Hess. [1957] 18p. Incl.
tables, refs. (AFOSR-TN-57-153) (Sponsored jointly
by Air Force Office of Scientific Research under AF 18-
(600)564 and Atomic Energy Commission under AT (11-
1)-101) AD 126443 Unclassified

Also published in Phys. Rev., v. 107: 540-542, July 15,
1957.

CHI.10:008; CHI.11:010, 011; CHI.12:027

The tritium and He^3 contents of the Norton County stone meteorite were measured. At the time of fall (1948) the tritium activity of two different specimens were $(.28 \pm .02)$ and $(.25 \pm .02)$ dpm/g. The measured He^3 contents per gram were $(2.27 \pm .11)$ and $(2.35 \pm .11) \times 10^{-6}$ cc STP, respectively. Experiments were made which indicate that there has been no appreciable loss of He^3 . The amount of He^3 accumulated and the tritium production rate combined give apparent He^3 - He^3 ages for irradiation of 420 and 480 million years, respectively. If an assumption is made as to the direct production rate of He^3 by spallation these ages reduce to 240 and 280 million years. The $A^{40}\text{-K}^{40}$ age of this meteorite is 4200 ± 700 million years. The possible significance of this difference in age is discussed. (Contractor's abstract)

CHI.10:008

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

TRITIUM ASSAYS OF NATURAL WATERS MEASURED IN 1956-1957, by F. Begemann. Dec. 31, 1957, 1v. incl. diagrs. tables, refs. (AFOSR-TR-58-41) (AF 18(600)-564) AD 154131 Unclassified

Rain and snow samples were collected from Chicago (Ill.), Bern (Switzerland), Reykjavik (Iceland), and various locations in the Arctic to obtain more detailed information on the distribution of excess tritium. In addition, the tritium content of Mississippi water was measured to study its relationship to the tritium content of precipitation. The tritium content of one set of annual layers of snow from Greenland covering the period from 1944 to 1956 was measured to obtain the amount of Castle and Redwing produced tritium deposited in this particular area as well as the natural production rate of tritium. The results on 3 more sets of snow samples from the Antarctic confirmed the previous finding that no detectable amounts of bomb tritium are deposited in this area. Finally, to further investigate the usefulness of tritium for the study of hydrological problems, the measurements on samples from Steamboat Springs, Nevada, were continued. The tritium contents of South Steamboat well and Spring no. 16 appeared to follow closely the marked change in the tritium contents of rain water from artificially produced tritium. Spring no. 80 showed an entirely different behavior. No pronounced peaks in the tritium content could be detected. Instead, following Castle, the tritium content increased about 4 T units, but did not show any subsequent decrease.

CHI.11:010

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

THE MEASUREMENT OF VERY SLOW REACTION

RATES: DECARBOXYLATION OF ALANINE, by D. Conway and W. F. Libby. Feb. 1957 [35]p. incl. diagrs. tables, refs. (AFOSR-TN-57-60) (AF 18(600)663) AD 115100 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 1077-1084, Mar. 5, 1958.

A method of measuring slow reactions using radioactive labelling and low level counting techniques has been applied to the decarboxylation of alanine at temperatures corresponding to half-lives from 0.1 to 10^4 years, the results being essentially in agreement with those which Abelson obtained at higher temperatures. The half-life for decarboxylation at room temperature is found to be about 10 billion years. A side reaction, which is most probably a short chain length radiation induced reaction, was controlling below 373°K and showed a half-life of about 10^5 years at room temperature at specific radioactivities of about 3 millicuries of C^{14} per mole of alanine. It also was found that O_2 attacks alanine to release carboxyl carbon at a rate corresponding to a half-life of about 20,000 years at room temperature.

CHI.11:011

Chicago U. Enrico Fermi Inst. of Nuclear Studies, Ill.

C^{14} HOT ATOM CHEMISTRY OF n-PENTANE AND iso-PENTANE, by C. F. MacKay and W. F. Libby. May 1957, 16p. incl. tables, refs. (AFOSR-TN-57-217) (AF 18(600)663) AD 126515 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 6366-6369, Dec. 20, 1957.

Reactions of C^{14} atoms of velocities corresponding to energies up to 40,000 electron volts have been studied in n-pentane and iso-pentane at about room temperature. C^{14} atoms were generated at the Argonne National Lab. pile through the reaction of thermal neutrons in the $\text{N}^{14}(\text{n,p})\text{C}^{14}$ process. Aniline was most often used as a source of nitrogen, but substitution of aliphatic amines gave similar results indicating that products were characteristic only of the hydrocarbon. A wide variety of hydrocarbons was formed. Hexane and pentane isomers were identified. Hexane isomers predominate, yields of individual compounds being up to 12%. The type and yield of compounds formed from n-pentane differ from those formed from iso-pentane. A mechanism is proposed. (Contractor's abstract)

CHI.12:027

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

IMPACT ZONES FOR SOLAR COSMIC-RAY PARTICLES, by R. Lüst. Dec. 10, 1956 [13]p. incl. diagrs.

CHL12:028 - CHL12:030

tables, refs. [AF 18(600)666]

Unclassified

Published in Phys. Rev., v. 105: 1827-1839, Mar. 15, 1957.

Orbits for cosmic-ray particles starting from the vicinity of the sun and passing through the geomagnetic dipole field were integrated by using the AVIDAC computer at the Argonne National Lab. The methods for integration used in Chicago and Göttingen were compared. Counting rates at the top of the atmosphere were calculated from the integrated orbits in order to make possible the analysis of cosmic-ray intensity increase during solar flares. Different source widths and declinations were assumed. The calculated counting rates are based on a flat rigidity spectrum at the source. This investigation shows that: (a) distinctive impact zones exist even for large source widths; (b) the position of these zones and the counting rates within these zones depend strongly upon the declination of the source; and (c) the earth's magnetic field produces a focusing effect especially at higher latitudes. (Contractor's abstract)

CHL12:028

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

CHANGES IN THE LOW-ENERGY CUTOFF AND PRIMARY SPECTRUM OF COSMIC RAYS, by P. Meyer and J. A. Simpson. 1957 [4p. incl. diagrs. (AFOSR-TN-57-531) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFRCRC Geophysics Research Directorate) AD 136517

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 192, Apr. 25, 1957.

Also published in Phys. Rev., v. 106: 568-571, May 1, 1957.

The low rigidity cutoff for primary particles in the cosmic-ray spectrum reappeared in 1956. From these new results and the earlier measurements in 1948, 1951, and 1954, it is clear that the shift of the low-rigidity cutoff to a very small value is restricted in time to an interval within which solar activity reached a minimum in the 11-year solar cycle. This effect was accompanied by other changes in the primary spectrum; namely (a), the total cosmic-ray intensity and (b) the exponent for the power law spectrum, both passed through maxima near the solar minimum in 1954. The 1956 results further support the view that these changes in the primary spectrum have their origin in a mechanism controlled by solar activity—most likely the diffusion of cosmic-ray particles through interplanetary disordered magnetic fields transported by plasma clouds of solar origin. If this is so, then only for a brief period near solar minimum is there

the possibility of access to the true galactic spectrum for particles below approximately 30 bev. (Contractor's abstract)

CHL12:029

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

SOLAR ORIGIN OF CHANGES IN THE PRIMARY COSMIC RADIATION, by J. A. Simpson. [1957] [15p. incl. diagrs. [AF 18(600)666] Unclassified

Published in Proc. Nat'l. Acad. Sciences, v. 43: 42-56, Jan. 1957.

The observed nonperiodic changes of primary cosmic-ray intensity within the solar system are considered briefly. It is concluded that they are either the result of occasional, de novo production in the region of the sun or the modulation of pre-existent radiation from outside the solar system. These variations represent changes in the primary spectrum over a wide range of particle energies involving over 95% of all the cosmic radiation. Since the modulation mechanism which produces these spectrum changes has its origin in solar activity, it is clear that only during periods of extreme minimum solar activity will it be possible to record briefly the galactic spectrum at the earth. Further studies of cosmic-ray intensity may: (1) add to knowledge of the electrodynamics of the solar system, and the nature of geomagnetic storms specifically; (2) place upper limits on the production of cosmic rays at the sun; and (3) provide further information on the galactic spectrum.

CHL12:030

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

ACCELERATION OF COSMIC RAYS IN SOLAR FLARES, by E. N. Parker. [1957] [7p. incl. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFRCRC Geophysics Research Directorate) Unclassified

Published in Phys. Rev., v. 107: 830-836, Aug. 1, 1957.

It is shown that the white-light cosmic-ray solar flare of Feb. 23, 1956 expended of the order of 2×10^{32} ergs of energy, or 10^4 ergs/cm³. The energy apparently came from a 500-gauss force-free magnetic field initially occupying the site of the flare. It is shown that the 500-gauss field, besides supplying the flare energy, will produce fluid motions of sufficient velocity to accelerate ions from thermal to relativistic energies by Fermi's mechanism in about 2 min. The theoretical energy spectrum of the model is in agreement with the observed spectrum. About 1% of the total flare energy is converted to relativistic particles and the remainder

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is dissipated through thermal processes to produce the observed optical radiation. (Contractor's abstract)

CHL12:031

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

NEWTONIAN DEVELOPMENT OF THE DYNAMICAL PROPERTIES OF IONIZED GASES OF LOW DENSITY, by E. N. Parker. [1957] [10]p. incl. diagrs. refs. [Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFRC Geophysics Research Directorate] Unclassified

Published in Phys. Rev., v. 107: 924-933, Aug. 15, 1957.

The macroscopic dynamical equations of a tenuous ionized gas in a magnetic field are developed by averaging over the individual ion and electron motions, which do not necessarily possess an isotropic distribution. It is shown that the principal motion of the gas is related to the magnetic field by the usual hydromagnetic equations, as developed for conducting liquids and dense gases; the anisotropy of the individual particle motions shows up primarily as a coefficient multiplying the pondermotive force exerted by the magnetic field on the plasma. The results reduce properly to the earlier work of Schlüter, Cowling, and Spitzer for isotropic pressure, and are in agreement with the recent developments from the Boltzmann equation. It is pointed out that the magnetic lines of force are permanently connected and move in the frame of reference of the electric drift. It is shown that near static equilibrium, when the principal motions vanish, there remain small macroscopic drift motions of the gas in the field of inhomogeneities. It is also shown that the field equations, obtained by assuming that the radius of gyration of the thermal motions is small compared to the scale of the field, are valid even near neutral surfaces, on which the field density vanishes. (Contractor's abstract)

CHL12:032

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

THE 24-HOUR INTENSITY VARIATIONS OF THE PRIMARY COSMIC RAYS, by A. M. Conforto and J. A. Simpson. [June 21, 1957] [11]p. incl. diagrs. [AF 18(600)666] Unclassified

Published in Nuovo Cimento, Serie X, v. 6: 1052-1062, Nov. 1, 1957.

The data from nucleonic component detectors (neutron intensity monitors) are analyzed for the amplitude and phase of maximum intensity of the 24 hr variation at the geomagnetic equator and at 48°N. The same analysis covers 1953-55, which includes the time of solar cycle (sunspot) minimum in 1954. During 1954 it is known that the 24 hr variation possesses an anomalous behavior.

It is shown that during 1954 there is an interval of 9 mo or more when the solar daily variation appears to undergo a progressive phase shift whose time of maximum lies in the range of 0800-1000 hr on a sidereal time scale. This anisotropy certainly exists in the radiation falling upon the atmosphere, and it is likely, although not proven, that the anisotropy prevails even outside the terrestrial field. The question of whether this sidereal effect is spurious or real is discussed in relationship to the recent results on the modulation of cosmic ray intensity within the solar system.

CHL12:033

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

INITIAL STAGES IN THE PROPAGATION OF COSMIC RAYS PRODUCED BY SOLAR FLARES, by R. Lüst and J. A. Simpson. [1957] [14]p. incl. illus. diagrs. tables, refs. [Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666] and AFRC Geophysics Research Directorate] Unclassified

Published in Phys. Rev., v. 108: 1-1576, Dec. 15, 1957.

The propagation of solar cosmic rays produced in the Feb. 23, 1956 flare have been studied from the time they leave the flare region to the time when the terrestrial cosmic-ray intensity reaches a maximum value. Within this interval there are observed not only strong anisotropies in the incident radiation, but also relatively large differences in time (≤ 9 min) between the commencements of the intensity increases in different parts of the world. This distribution of time delays is superposed upon the transit-time delay which all particles experience between production and detection. From these experimental results, and the calculations of orbits connecting the sun and earth at the time of the flare, it is shown that there are broad impact zones on the earth within the first 10 min of the cosmic-ray intensity increases. Using the recently deduced flare-particle spectrum, cosmic-ray intensities at the top of the atmosphere have been determined for the different impact zones. For this flare event the "2000 hr" impact zone becomes as important as the "0900" and "0300" hr impact zones. These results demonstrate that the first flare particles arriving at the earth were not of low energy, and that the low-energy particles arrived later - the delay being an inverse function of energy. This energy-dependent spread of first arriving particles is called the dispersion effect arising from the mode of particle propagation from the flare source to the earth. These conclusions show that back scattering from disordered magnetic fields beyond the orbit of the earth account for the time delays. Various alternatives are considered for production of this distribution of onset times. The most likely process appears to be propagation through magnetic fields by diffusion. Since the impact-zone data for all geomagnetic latitudes, including both polar regions, predict a distant source in the direction of the sun but of order one radian solid angle in the sky, and since

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sufficient diffusion around the earth to produce the required time delays would destroy the observed impact-zone effects. It is suggested that there may exist a diffusing envelope around the sun which accounts for both the apparent source size and the dispersion effect. Small irregularities in the general solar dipole field are invoked to produce the diffusion. Calculations show that the predicted dispersion effect agrees with the observations, and that other details following from diffusion are satisfied. There is evidence of a dispersion effect for the flare particles of Nov. 19, 1949. The implications of these results for possible magnetic-field distributions between the sun and earth are reviewed, and it is shown from the orbit calculations and the dispersion effects that the predictions are not in agreement with observations. There is a transition period between the time when impact zones are dominant and the time when isotropy sets in. The subsequent storage of the solar cosmic-ray particles is not further considered in this paper, except for the bearing of these observations at early times upon the character of the interplanetary storage magnetic fields. (Contractor's abstract)

CHL12:034

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

SWEET'S MECHANISM FOR MERGING MAGNETIC FIELDS IN CONDUCTING FLUIDS, by E. N. Parker. [June 4, 1957] [12]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Jour. Geophys. Research, v. 62: 509-520, Dec. 1957.

Sweet's mechanism for the merging of two oppositely directed magnetic fields in a highly conducting fluid is investigated in a semi-quantitative manner. It is shown that two oppositely directed sunspot fields with scales of 10^4 km could be merged by Sweet's mechanism, if shoved firmly together in about two weeks; their normal inter-diffusion time would be of the order of 600 years. It is suggested that Sweet's mechanism may be of considerable astrophysical importance. It gives a means of altering quickly the configuration of magnetic fields in ionized gases, allowing a stable field to go over into an unstable configuration, subsequently converting much of the magnetic energy into kinetic energy of the fluid. (Contractor's abstract)

CHL12:035

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

COSMIC-RADIATION NEUTRON INTENSITY MONITOR, by J. A. Simpson. [1957] [23]p. incl. illus. diagr. tables. [AF 18(600)666] Unclassified

Published in Ann. IGY, v. 4: 351-373, 1957.

A report on instrumentation for measuring cosmic-ray intensity changes is presented. The instrumentation developed for measurement and registration of cosmic-ray neutron intensity changes with time is described.

CHL12:036

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

COHERENT ELECTRON OSCILLATIONS IN NONUNIFORM PLASMAS AND THEIR INTERACTION WITH ELECTROMAGNETIC FIELDS. III. INTERPENETRATION OF ELECTRON AND ION STREAMS, by E. N. Parker. Nov. 1958 [31]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFCRC Geophysics Research Directorate) Unclassified

It is shown that a high speed electron stream passing through a cloud of ions will excite ion waves with energies comparable to the initial electron energies. The process is suggested for the ignition of thermonuclear devices. (Contractor's abstract)

CHL12:037

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

ORIGIN AND DYNAMICS OF COSMIC RAYS, by E. N. Parker. [1958] [17]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Phys. Rev., v. 109: 1328-1344, Feb. 15, 1958.

As a consequence of our inability to observe directly the origin of a cosmic-ray particle, we begin the development with a discussion of the limitations within which we can construct a cosmic-ray accelerator mechanism. We find that we are allowed only the betatron effect and Fermi mechanism. We review some of the many variations of these mechanisms which are to be found in the literature. Then it is shown that trains of oppositely moving hydromagnetic waves of large amplitude and with sharp crests can accomplish large and continued particle accelerations which are adequate to maintain the observed galactic cosmic-ray field. The large acceleration arises as a consequence of the simple fact that each wave tends to sweep up the cosmic-ray particles before it, so that head-on collisions of particles with waves are much more common than overtaking collisions. It is pointed out that the sharp crests of the waves are a natural consequence of the observed supersonic mass motions. Therefore, the acceleration by oppositely moving waves does not depend upon any special wave form, and we suggest that it is the naturally occurring acceleration process. By

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treating the cosmic rays as a gas with relativistic thermal motions, it is shown that the cosmic-ray gas is effectively coupled to the motions of the ordinary matter both parallel and perpendicular to the magnetic field. Thus the effective speed of sound must be computed in the composite cosmic-ray and ordinary gas. It is noted that with this composite speed of sound the irregular mass motions in the galactic disk and halo are approximately Mach one. It is suggested that this represents a general dynamic balance to be found in all sufficiently active regions of space, and explains how it is that we often observe prolonged mass motions in the galaxy and in stellar atmospheres which would otherwise be computed to be highly supersonic and dissipative. The dynamic balance comes about from the fact that increased cosmic-ray density would reduce the effective Mach number below one, allowing the sharp crests of the hydromagnetic waves to degenerate, and thereby halting the production of cosmic-ray particles. (Contractor's abstract)

CHI.12:038

Chicago U. Enrico Fermi Inst. for Nuclear Research, Ill.

REACTION OF LABORATORY MAGNETIC FIELDS AGAINST THEIR CURRENT COILS, by E. N. Parker. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Phys. Rev., v. 109: 1440, Mar. 1, 1958.

It is shown, using the virial theorem, that the forces exerted on a current-carrying wire by the magnetic field of the current in the wire are always of the same order as the stresses carried by the magnetic field. Thus it is possible, by suitable configuration of the current-carrying wires, to construct a magnetic system wherein the currents are free of magnetic stresses, even for the so-called "force free" fields. (Contractor's abstract)

CHI.12:039

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

DYNAMICAL INSTABILITY IN AN ANISOTROPIC IONIZED GAS OF LOW DENSITY, by E. N. Parker. [1958] [3]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFCRC Geophysics Research Directorate) Unclassified

Published in Phys. Rev., v. 109: 1874-1876, Mar. 15, 1958.

It is shown that when the thermal motions of a tenuous ionized gas are sufficiently anisotropic, the gas, and the initially uniform magnetic field which the gas is

assumed to contain, become unstable. One mode of instability occurs when the gas pressure is greater parallel to the field than perpendicular, and another mode when the pressure is greater perpendicular than parallel. It is suggested that such instabilities may be of astrophysical interest, particularly with regard to the configuration of the solar dipole field as it is drawn out into interplanetary space by ionized gas from the sun. (Contractor's abstract)

CHI.12:040

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

CHANGES OF THE PRIMARY α -PARTICLE FLUX OF COSMIC RADIATION DURING HIGH SOLAR ACTIVITY (Abstract), by P. Meyer. [1958] [1]p. [AF 18(600)666] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 221, May 1, 1958.

During the months of Aug. and Sept., 1957, the flux of the primary α -particle component was measured at the northern magnetic latitude of 61°. This report based on two flights which followed the sharp decrease of total cosmic-ray intensity on Aug. 30, 1957. It was found that from flight to flight the average proton and α -particle intensities undergo changes consistent with the concept that a common modulating mechanism is operating on both primary components. For each flight a detailed study of the intensity-time variations within 8 hr of observation reveals a large change in the α -particle flux not accompanied by a comparable variation in the proton intensity. We tentatively ascribe this to an anisotropy in the α -particle flux. Such an independent variation is not a consequence of any modulating mechanism so far considered.

CHI.12:041

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

INTERACTION OF THE SOLAR WIND WITH THE GEOMAGNETIC FIELD, by E. N. Parker. [1958] [17]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Phys. Fluids, v. 1: 171-187, May-June 1958.

The dynamical properties of the solar wind blowing past the geomagnetic field are investigated by considering the effective viscosity and the resulting transition layer thickness. The collision of ions in the solar wind produces a negligible viscosity in the flow past the

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geomagnetic field, but such an inviscid flow is shown to be unstable. The resulting disordered interface between the field and the wind yields Fermi acceleration of ions and consequently a not insignificant effective viscosity. The Fermi acceleration results in suprathermal ions which may have an energy spectrum like that observed for primary auroral protons. The auroral zones and the agitated nature of the polar geomagnetic field are shown to follow from the depth of penetration of the solar wind into the geomagnetic field. The injection of gas into the geomagnetic field is studied. The effect at Earth of the distortion of the outer boundary of the geomagnetic field is computed; no matter how unevenly and anisotropically the outer field is distorted, the effect at Earth is a nearly uniform perturbation field which is closely parallel to the geomagnetic axis. Pushing in on the outer field increases the horizontal component at Earth, and pulling out decreases it; the total increase of the horizontal component is the algebraic sum of the pushing and pulling. The simultaneous worldwide onset and the main phase of a geomagnetic storm follow. The common tendency of large and/or violent bodies of plasma to produce suprathermal particles is noted and suggested to be a general dynamical property. (Contractor's abstract)

CHI.12:042

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

COSMIC RAY MODULATION BY THE SOLAR WIND, by E. N. Parker. [1958] [5]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFCRC Geophysics Research Directorate) Unclassified

Published in Phys. Rev., v. 110: 1445-1449, June 15, 1958.

It is shown that the hydrodynamic outflow of gas from the sun observed by Biermann results in a reduction of the cosmic-ray intensity in the inner solar system during the years of solar activity. The computed cosmic-ray energy spectrum so closely resembles the observed spectrum at earth that we suggest the outflow of gas to be the explanation for the 11-yr variation of the cosmic-ray intensity. It is also suggested that perhaps the Forbush-type decrease, which is a local geocentric phenomenon, is the result of disordering of the outer geomagnetic field by the outflowing gas from the sun. (Contractor's abstract)

CHI.12:043

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

ELECTRICAL CONDUCTIVITY IN THE GEOMAGNETIC STORM EFFECT, by E. N. Parker. [1958] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Jour. Geophys. Research, v. 63: 437-438, June 1958.

The suggestion of Hines (Jour. Geophys. Research, v. 62: 491-492, Sept. 1957), that a magnetic field due to a ring current may penetrate rapidly through the electrically conducting gas surrounding the earth because of the geomagnetic field, is shown to be not in accord with electromagnetic theory.

CHI.12:044

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

SUPRATHERMAL PARTICLES. I, by E. N. Parker and D. A. Tidman. [1958] [6]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Phys. Rev., v. 111: 1206-1211, Sept. 1, 1958.

The production of suprathermal particles in agitated plasmas bearing magnetic fields is discussed. The role of such particles in astrophysics and in the problem of the production of thermonuclear power is considered. (Contractor's abstract)

CHI.12:045

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

SUPRATHERMAL PARTICLES. II, by D. A. Tidman and E. N. Parker. [1958] [4]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Phys. Rev., v. 112: 1048-1051, Nov. 15, 1958.

The production of thermal particles in an agitated plasma bearing magnetic fields was discussed in a previous paper (item no. CHI.12:044). Here we consider more refined models for the magnetic fields in the plasma and suggest that experiments be done to study this phenomenon. (Contractor's abstract)

CHI.12:046

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

COSMIC-RAY PRODUCTION OF POSITRONS AND ELECTRONS IN THE GALAXY (Abstract), by F. C. Jones. [Nov. 1958] 1p. (AF 18(600)666) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago U., Ill., Nov. 28-29, 1958.

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Published in Bull. Amer. Phys. Soc., Series II, v. 3: 362, Nov. 26, 1958.

The interaction of cosmic rays with interstellar hydrogen throughout the galaxy produces stable secondaries, such as γ rays and e^{\pm} . The electrons and positrons are derived from the sequence of reactions $N + N \rightarrow N + N + \pi^{\pm}$, $\pi^{\pm} \rightarrow \mu^{\pm} + \nu$, $\mu^{\pm} \rightarrow e^{\pm} + 2\nu$ (N = nucleon). Their flux has been calculated to be the same order of magnitude as the primary cosmic-ray proton flux but depends upon the density of interstellar hydrogen and galactic trapping magnetic fields. An approximate energy spectrum has been determined with a peak in the distribution well below 100 mev. The experimental determination of the electron-positron flux is of interest since the flux depends upon basic parameters of the galaxy. The existence of the geomagnetic field makes difficult the direct observation of such a low-energy particle distribution, and the low-energy charged particle cut-off recently shown to depend upon solar activity further limits the observational possibilities.

CHL12:047

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

DYNAMICS OF THE INTERPLANETARY GAS AND MAGNETIC FIELDS, by E. N. Parker. [1958] [13]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFCRC Geophysics Research Directorate)

Unclassified

Published in Astrophys. Jour., v. 128: 664-676, Nov. 1958.

We consider the dynamical consequences of Biermann's suggestion that gas is often streaming outward in all directions from the sun with velocities of the order of 500-1500 km/sec. These velocities of 500 km/sec and more and the interplanetary densities of 500 ions/cm³ (10^{14} gm/sec mass loss from the sun) follow from the hydrodynamic equations for a 3×10^6 K solar corona. It is suggested that the outward-streaming gas draws out the lines of force of the solar magnetic fields so that near the sun the field is very nearly in a radial direction. Plasma instabilities are expected to result in the thick shell of disordered field (10^{-5} gauss) inclosing the inner solar system, whose presence has already been inferred from cosmic-ray observations. (Contractor's abstract)

CHL12:048

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

SUPRATHERMAL PARTICLE GENERATION IN THE SOLAR CORONA, by E. N. Parker. [1958] [9]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFCRC Geophysics Research Directorate)

Unclassified

Published in Astrophys. Jour., v. 128: 677-685, Nov. 1958.

It is shown that hydromagnetic waves propagating outward through the solar corona will convert all but a small portion of their energy into suprathermal particles. It is suggested that this is the source of the 3×10^{28} ergs/sec necessary to maintain 2×10^6 K solar corona with its continued expansion into solar wind. The temperature of the solar corona will then correspond to an ion thermal velocity of the same order of magnitude as the hydromagnetic wave velocity. (Contractor's abstract)

CHL12:049

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

SUPRATHERMAL PARTICLES. III. ELECTRONS, by E. N. Parker. [1958] [7]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFCRC Geophysics Research Directorate)

Unclassified

Published in Phys. Rev., v. 112: 1429-1435, Dec. 1, 1958.

Certain phenomena in nature, such as the 50- to 100 kev electrons of the aurora, suggest that there are plasma-dynamical processes which can quickly transfer the translational energy of the ions in a plasma stream to the electrons (some 20 kev/ion for a 2000-km/sec solar wind). It is shown that two interpenetrating streams of noncolliding and initially neutral plasma can achieve this energy transfer with a characteristic time comparable to $(M/m)^{1/2}$ times the plasma period. The process is closely analogous to the excitation of plasma oscillations by two interpenetrating electron streams, but of course proceeds to much greater electron energies because the ion components of the streams carry so much more kinetic energy than do the electron components. Hence, besides the auroral electrons, it is probably responsible for solar radio emission, rather than the electron streams implied in current theories. Further, the process is probably the dominant interaction in shock fronts, particularly in astrophysical cases where neither direct collisions nor the existing weak magnetic fields can give sharp fronts. The characteristic thickness of a shock front in the solar wind is of the order of 10^4 cm due to the above plasma excitation whereas the Larmor radius of the ions, which would

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otherwise determine the shock thickness in the absence of collisions, is 100 km or more. (Contractor's abstract)

CHL12:050

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

INADEQUACY OF RING CURRENT FOR MAIN PHASE OF A GEOMAGNETIC STORM, by E. N. Parker. [1958] [7]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and AFCRC Geophysics Research Directorate) Unclassified

Published in Jour. Geophys. Research, v. 63: 883-889, Dec. 1958.

It is demonstrated that there is apparently not enough dissipation to allow significant diffusion, during a magnetic storm, of the magnetic fields in the vicinity of the earth. It is then demonstrated that a ring-current field can only increase the horizontal component of the geomagnetic field, and so cannot account for the main phase of a geomagnetic storm. Thus, other mechanisms must be sought.

CHL12:051

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

FURTHER EXPERIMENTS CONCERNING THE GEOMAGNETIC FIELD EFFECTIVE FOR COSMIC RAYS, by L. Katz, P. Meyer, and J. A. Simpson. [1958] [6]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Published in Nuovo Cimento, Series X, Suppl. v. 8: 277-282, 1958.

Preliminary results of the cosmic ray measurements undertaken to determine the cosmic ray equator are presented. Constant pressure measurements were carried out at 18,000 ft. and 12 flights with equatorial crossings were made. A short discussion is given of the question of the suitability of local field measurements at the surface of the earth and of harmonic analysis of the earth's magnetic field to describe the field distribution which is necessary for cosmic ray analysis.

CHL12:052

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

IMPACT ZONES FOR SOLAR COSMIC RAY PARTICLES,

by R. List. [1958] [4]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Published in Nuovo Cimento, Series X, Suppl., v. 8: 176-179, 1958.

Using previously calculated orbits (see item no. CHL12:027) the primary particle rigidities and the relative counting rates at the top of the atmosphere as a function of position on the earth are given for the solar flare event on Feb. 23, 1958. It is found that the first particles to arrive were those of high magnetic rigidity.

CHL12:053

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

NEW CHANGES IN THE LOW-ENERGY PARTICLE CUT-OFF AND SPECTRUM OF THE PRIMARY COSMIC RADIATION, by P. Meyer and J. A. Simpson. [1958] [4]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Published in Nuovo Cimento, Series X, Suppl., v. 8: 233-236, 1958.

An account is given of the data collected in high altitude aircraft observation of cosmic ray events in 1956. Comparison is made with earlier results on the low-energy cut-off and energy spectrum of the radiation. A more detailed account is given in item no. CHL12:028.

CHL12:054

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

SOLAR FLARE COSMIC RAYS AND THEIR PROPAGATION, by J. A. Simpson. [1958] [28]p. incl. diagrs. tables, refs. [AF 18(600)666] Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Published in Nuovo Cimento, Series X, Suppl., v. 8: 133-160, 1958.

A number of points concerning the propagation and arrival at the earth of solar cosmic rays are investigated by means of an analysis of the flare event of Feb. 23,

CHI.20:001 - CHI.20:004

1956. The intensity profile at Chicago and the time delay of arrival of low energy particles on a world scale are given. A discussion is presented of the possibility of diffusion mechanism to account for the time delay observed for the low energy particles and of the transition from zone anisotropy of particle incidence to a general isotropy of cosmic ray events.

CHI.20:001

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

OBSERVATION OF A π^0 - MESONIC DECAY OF A HELIUM HYPERNUCLEUS, by R. Levi-Setti and W. E. Slater. Apr. 1958, 10p. incl. diagrs. tables. (AFOSR-TN-58-464) (AF 49(638)209) AD 158271

Unclassified

Also published in Phys. Rev., v. 111: 1395-1397, Sept. 1, 1958.

The observation of a hypernucleus decaying into an electron pair, a recoil, and one or more neutral particles, is reported. The event was produced by a K^- capture in emulsion. The charge of the hypernucleus was determined as $Z=2$. The most probable interpretation of this unusual event is the reaction $\Lambda \text{He}^4 - \pi^0 + \text{He}^4$. However, $\Lambda \text{He}^{4,5} - \pi^0 + n + \text{He}^{3,4}$ cannot be ruled out, since a reliable determination of the energy of the electrons at emission cannot be made. (Contractor's abstract)

CHI.20:002

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

A SYSTEMATIC STUDY OF HYPERFRAGMENTS PRODUCED BY 4.5 GeV π^- IN NUCLEAR EMULSION. I. π^- - MESIC DECAYS, by W. E. Slater. [July 9, 1958] [80]p. incl. diagrs. tables, refs. (AFOSR-TN-58-573) (AF 49(638)209) AD 158934

Unclassified

Also published in Nuovo Cimento, Series X, Suppl., v. 10: 1-40, 1958.

An experimental study was undertaken to establish the Λ -particle binding energies (B_Λ) for several hyper-nuclides with an accuracy comparable to the present uncertainty in the value of Q_Λ , the energy released in the decay of free Λ . Only events best suited to yield binding energies, those in which a negative pion is emitted, are considered. An emulsion stack of fifty 1-mm and thirty-five 0.6 mm Ilford G-5 pellicles, 4 in. by 6 in. in area, was exposed to a beam of 4.5 GeV π^- at the bevatron. The most energetic pion beam from the bevatron was chosen because in pion-nucleon collisions a substantial center-of-mass energy is produced from this beam. This increases the chance to produce a slowly

moving Λ hyperon which may become attached to a nuclear fragment. Two decay modes mass number (A) = 4 of the hydrogen hyperfragments, were identified. Twenty-one He_Λ decays, 2 Be_Λ decays, 5 Li_Λ decays, and 5 unidentified hyperfragments were also found. The binding energy increases monotonically with A through $A=9$, according to available reliable data. Because the density of nuclear matter is independent of A , the potential well in which the Λ is bound is expected to have a constant depth. No events with $A < 4$ were identified. Detection for the first time was made of mesic decays of both members of the $A=8$ doublet, Li_Λ and Be_Λ . (ASTIA abstract)

CHI.20:003

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

A RE-ANALYSIS OF THE EXPERIMENTAL DATA ON HYPERNUCLEI DECAYING BY π^- EMISSION, by R. Levi-Setti, W. E. Slater and V. L. Telegdi. [July 9, 1958] [34]p. incl. diagrs. tables, refs. (AFOSR-TN-58-574) (AF 49(638)209) AD 158395

Unclassified

Excerpt published in Proc. 1958 Annual Internat'l. Conf. on High Energy Physics at CERN, European Organization for Nuclear Research, Geneva (Switzerland) (June 30-July 5, 1958), Geneva, CERN, Scientific Information Service, p. 327.

Also published in Nuovo Cimento, Series X, Suppl., v. 10: 68-90, 1958.

Existing surveys on hypernuclei are re-analyzed in an attempt to standardize procedures for identifying events and deducing binding energies. A detailed description of the salient features of the events considered and of the criteria adopted are presented. The following information is considered pertinent to the analysis of a hyperfragment decay: (1) data on the primary track, range, latitude, evidence for stopping (tapering or multiple scattering), charge (δ -ray count, or profile measurement), measured mass, and characteristics of the primary star; (2) data on the secondary star prongs, ranges, latitudes, longitudes, errors in these 3, and identities; and (3) thickness and density of the emulsions. The extraction of reliable hypernuclear binding energies is desired so all events decaying non-mesonically are ignored.

CHI.20:004

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

A SYSTEMATIC STUDY OF HYPERFRAGMENTS PRODUCED BY 4.5 GeV π^- IN NUCLEAR EMULSION. II. NON-MESIC DECAYS, by E. M. Silverstein. [Nov. 1958] 27p. incl. diagrs. tables. (AFOSR-TN-58-987) (AF 49(638)209) AD 205911

Unclassified

Published in Nuovo Cimento, Series X, Suppl., v. 10: 41-67, 1958.

Hyperfragment decay without pion emission is analyzed. Only those events which originate from a primary star associated with a visible beam track are considered. The probable number of actual hyperfragments was estimated on a statistical basis under homogeneous conditions of production and detection. Careful measurements on the decay products of such events identified 44 non-mesic definite hyperfragments as specific hyper-nuclides. The non-mesic/mesic decay ratios can be estimated from the results. Definite hyperfragments are identified from the characteristics of the connecting tracks, e.g., thin-down, δ -rays, ionization, and scattering near the end of the range. This type of analysis is only possible for events having fairly long connecting tracks. The majority of the possible hyperfragments (GOKs) had connecting tracks shorter than 20 μ m. A total of 216 GOKs and 56 definite hyperfragments were found. Connected stars can be definitely classed as non-mesic decays of definite hyperfragments in a limited number of cases. These cases represent about 0.2 of the connected stars. Several methods were used to estimate the Z spectrum of the hyperfragments and the non-mesic to mesic ratio as a function of Z. The methods made use of the prong-number distribution of the decays and of the results of the analysis of the events with the aid of an IBM 650 computer. A forward to backward ratio of 2.2 ± 0.5 was found for the production of hyperfragments. (ASTIA abstract)

CHI.13:008

Chicago U. [Inst. for the Study of Metals] Ill.

IMPURITY DIFFUSION IN COPPER (Abstract), by C. T. Tomizuka. [1957] [1]p. [AF 18(600)1489]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 123, Mar. 21, 1957.

In order to study the effect of the atomic size of diffusing elements on the impurity diffusion rate diffusion of silver and gold in single crystals of copper was measured. While gold atoms expand the copper lattice approximately 30% more effectively than silver atoms do, the diffusion rate of silver in copper was found to be 4 times faster than that of gold. The results can be expressed as $D = 0.69 \exp(-49\,700/RT) \text{ cm}^2/\text{sec}$ and $D = 0.23 \exp(-44\,000/RT) \text{ cm}^2/\text{sec}$ for the diffusion in copper of gold and of silver, respectively. Preliminary results on the diffusion of electropositive elements in copper will be reported.

CHI.13:009

Chicago U. Inst. for the Study of Metals, Ill.

VOLUME CHANGE OF INDIUM ANTIMONIDE DURING FUSION, by N. H. Nachtrieb and N. Clement. Feb. 17, 1958 [15]p. incl. diagrs. table. (AFOSR-TN-58-71) (AF 18(600)1489) AD 148114 Unclassified

Also published in Jour. Phys. Chem., v. 62: 747-750, June 1958.

The change in volume of indium antimonide on fusion has been determined from measurements of the change in pressure of argon at constant volume. The average of six determinations gives $100 \Delta V/V_s = -13.68 \pm 0.05\%$, referred to the solid. (Contractor's abstract)

CHI.13:010

Chicago U. Inst. for the Study of Metals, Ill.

HEAT OF FUSION AND HEAT CAPACITY OF INDIUM ANTIMONIDE, by N. H. Nachtrieb and N. Clement. [1958] [2]p. (AFOSR-TN-58-110) (AF 18(600)1489) Unclassified

Also published in Jour. Phys. Chem., v. 62: 876-877, July 1958.

The heat of fusion was found to be 11.2 kcal/mol by the simple drop calorimetric method. The entropy of fusion was 14.1 cal/degree-mol. The heat capacities of InSb at 20-90°, 90-170°, 170-350° and 350-500° were 0.052, 0.056, 0.062 and 0.062 cal/g-degree, respectively.

CHI.13:011

Chicago U. Inst. for the Study of Metals, Ill.

EXPERIMENTAL DETERMINATION OF THE ELECTRICAL RESISTIVITY OF THE LIQUID ALLOYS Hg-In, Hg-Tl, and Ga-Sn, AND OF LIQUID GALLIUM, by L. G. Schulz and P. Splegler. Mar. 6, 1958 [14]p. incl. illus. tables, refs. (AFOSR-TN-58-149) (AF 18(600)1489) AD 152176 Unclassified

A potentiometric method was used to determine the resistivity and the temperature coefficient of the resistivity of several alloys which are liquid at room temperature. Pure Hg was used as the reference material. It was found that the solution of In or Tl in Hg caused a large decrease in the resistivity whereas the solution of In or Sn in Ga caused a slight increase. For solutions of Tl in Hg closely corresponding to Hg_5Tl_2 at room temperatures above 16°C there were no anomalies in the electrical properties. However, in the range of 16°C down to the melting temperature at 14.5°C the temperature

CHL13:012 - CHL13:016

coefficient decreases to zero at 14.5°C. The conclusions from electrical measurements are in general inconsistent with those from x-ray experiments which suggest that there is a more orderly atomic arrangement in the liquid at those compositions which correspond to compounds. The resistivity of liquid Ga was found to be in good agreement with that obtained by Bridgman. (Contractor's abstract)

CHL13:012

Chicago U. Inst. for the Study of Metals, Ill.

ON HART'S THEORY ON THE ROLE OF DISLOCATION IN BULK DIFFUSION, by C. T. Tomizuka. Apr. 9, 1958 [8]p. incl. table. (AFOSR-TN-58-272) (AF 18-(600)1489) AD 154173; PB 133964 Unclassified

Also published in Acta Metallurgica, v. 6: 660-661, Oct. 1958.

An analysis has been attempted of previously quoted experimental bulk diffusion data of antimony in silver in order to discover a gradual decrease of the activation energy with decreasing temperature as predicted by Hart's theory (Acta Metallurgica, v. 5: 597, 1957) of the short-circuiting effect of dislocations on the diffusion process. The change in slope between adjacent points of a $\log D$ vs $1/T$ plot has been examined for experimental data on single crystals which have values of D larger than 10^{-12} cm²/sec and only for those pairs of points with temperature intervals sufficiently large to give $\Delta(1/T) \geq 4 \times 10^{-5}$ /deg. The contributions of the short-circuiting elements amount to as much as 9% at 650°C for the diffusion of antimony in silver and 4% for the diffusion of silver in silver and are in general agreement with expectations.

CHL13:013

Chicago U. Inst. for the Study of Metals, Ill.

SELF-DIFFUSION IN SILVER DURING PLASTIC DEFORMATION IN EXTENSION AND COMPRESSION, by J. B. Darby, Jr., C. T. Tomizuka, and R. W. Balluffi. Nov. 14, 1958 [35]p. incl. diagrs. tables, refs. (AFOSR-TN-58-941) (AF 18(600)1489) AD 205085 Unclassified

Also published in Jour. Appl. Phys., v. 30: 104-112, Jan. 1959.

Self-diffusion in single crystals of silver has been studied by the use of samples which have been plated with the radioactive isotope Ag¹¹⁰. The single crystals were subjected to tension and compression at both 800 and 900°C, and the deformed crystals were studied by a special sectioning technique. The experiments indicate that within the experimental error, the diffusion rates

are not changed by simultaneous deformation.

CHL13:014

Chicago U. Inst. for the Study of Metals, Ill.

IMPROVEMENTS ON A SIMPLE TEMPERATURE CONTROLLER, by C. T. Tomizuka and D. Zimmerman. Nov. 14, 1958 [5]p. incl. diagr. (AFOSR-TN-58-942) (AF 18(600)1489) AD 205084; PB 138420 Unclassified

Also published in Rev. Scient. Instruments, v. 30: 40, Jan. 1959.

A circuit was developed to be an improvement over a single controller previously developed by Wilson and presently enjoying use in many laboratories. It uses a transistor preamplifier followed by a small thyatron activating relay. The buzz frequency can attain 10 c/sec, a frequency which would destroy an ordinary relay.

CHL13:015

Chicago U. Inst. for the Study of Metals, Ill.

SELF-DIFFUSION IN LIQUIDS AND CRYSTALLINE SOLIDS, by N. H. Nachtrieb. [1958] [4]p. (AF 18(600)-1489) Unclassified

Published in Proc. Second U. N. Internat'l. Conf. on the Peaceful Uses of Atomic Energy, Geneva (Switzerland), v. 20: 104-107, 1958.

Rates of self-diffusion as a function of pressure and temperature in solid Pb and liquid Na, In, Sn, Hg, and Ga are given. It is shown that the results may be expressed in terms of single variable, the reduced temperature.

CHL13:016

Chicago U. Inst. for the Study of Metals, Ill.

TRANSPORT PROPERTIES IN PURE LIQUID METALS, by N. H. Nachtrieb. [1958] [7]p. incl. diagr. tables, refs. (AF 18(600)1489) Unclassified

Published in Seminar on Liquid Metals and Solidification, Chicago, Ill. (Nov. 2-8, 1957), Cleveland, Amer. Soc. for Metals, 1958, p. 49-55.

Some of the author's observations which cast doubt upon the adequacy of so simple a thermally activated state for diffusion and viscous flow in liquid metals are presented. The observations noted and discussed are: (1) Magnitude of D_0 , (2) Cohesive Energy, (3) Activation Volume, (4) Viscosity and Diffusion, and (5) Effect of Pressure on Viscosity.

CHL15:009 - CHL15:012

CHL15:009

Chicago U. Lab. of Molecular Structure and Spectra, III.

[COMPUTATIONS IN QUANTUM CHEMISTRY], by R. S. Mulliken, J. R. Platt and others. Technical rept. 1956, 224p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-654) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)471, Office of Naval Research under N6ori-2009, Office of Ordnance Research under DA-11-022-ord-1002, and AFCRC Geophysics Research Directorate under AF 19-(604)1019) AD 144491 Unclassified

This report covers joint research performed during the period Oct. 1, 1955 through Dec. 31, 1956. Fourteen technical papers are included.

CHL15:010

Chicago U. Lab. of Molecular Structure and Spectra, III.

SCF LCAO MO STUDY OF Li_2 , by J. E. Faulkner.

[1957] [5]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)471, Office of Naval Research under N6ori-2009, and Atomic Energy Commission) Unclassified

Published in Jour. Chem. Phys., v. 27: 369-373, Aug. 1957.

An LCAO molecular orbital calculation using the full six-electron Hamiltonian has been performed on Li_2 at a nuclear separation equal to the experimental internuclear distance. The molecular wave function consisted of one antisymmetrized product made up of molecular orbitals formed as the best linear combinations of Slater 1s, 2s, and $2p_z$ atomic orbitals. The orbital exponents for these atomic orbitals were respectively 2.69, 0.64, and 0.53 as determined by a variational calculation on the lithium atom. In computing the molecular dissociation energy, the energy of two separated lithium atoms was taken to be that obtained by this variational calculation. The computed dissociation energy was found to be 0.33 ev compared with the experimental value of 1.05 (where a slight correction for zero-point energy has been made). The ratio of the computed molecular ground-state energy to the experimental is 0.9902 while the difference of these quantities is 4.00 ev. Certain other molecular constants are calculated and compared with available experimental data.

CHL15:011

Chicago U. [Lab. of Molecular Structure and Spectra] III.

COMPUTATION OF ELECTRONIC PROPERTIES OF FIRST-ROW DIATOMIC MOLECULES BY DIGITAL COM-

PUTER (Abstract), by A. D. McLean, P. I. Merryman and others. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)471], Office of Naval Research, and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 139-140, Mar. 27, 1958.

Programs for computing all necessary one- and two-center integrals involving Slater-type atomic orbitals (AO's) for quantum numbers $n = 1, 2$ ($n = 3$ in the case of the one-electron integrals) have been written for the Scientific Univac and are now operating. Programs for the calculation of certain types of three-center integrals for almost any n , but for a maximum 1 of 7 are also operating. Description and discussion of results for the various integral programs are given. An SCF procedure for computation of LCAO molecular orbitals has been programmed and is operating. This, coupled with the integral programs, provides a complete computational tool for the determination of "best-LCAO-MO" eigenfunctions (obtained by varying the exponents of the atomic orbitals and the coefficients of the LCAO-MO's) for ground and excited states of first-row homopolar, heteropolar, and hydride molecules. From these eigenfunctions (further improved by configuration interaction), calculation of molecular energies and other properties can be computed. Initial results are discussed.

CHL15:012

Chicago U. [Lab. of Molecular Structure and Spectra] III.

CORRELATED WAVE FUNCTION FOR THE GROUND STATE OF HELIUM-LIKE SYSTEMS (Abstract), by C. C. J. Roothaan. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)471], Office of Naval Research, and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 139, Mar. 27, 1958.

The ground state of a helium-like system is represented by a wave function of the form $\phi(r_1)\phi(r_2)\chi(r_{12})$, where ϕ and χ are functions to be determined by minimizing the energy. Unlike many other approximate wave functions, a wave function of this form has the proper singularities for $r_1 \rightarrow 0$, $r_2 \rightarrow 0$, $r_{12} \rightarrow 0$ if ϕ and χ have the right slopes at these points. An actual calculation was done for the helium atom. Simple expansions in terms of polynomials and exponentials were put forward for ϕ and χ , and the energy was minimized with

CHI. 15:013, 014; CIN. 04:001

respect to the coefficients and exponents. The resulting wave function accounts for 92% of the correlation energy.

CHI. 15:013

Chicago U. [Lab. of Molecular Structure and Spectra] Ill.

BROKEN BOTTLENECKS AND THE FUTURE OF MOLECULAR QUANTUM MECHANICS (Abstract), by R. S. Mulliken and C. C. J. Roothaan. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)471], Office of Naval Research, and National Science Foundation) Unclassified

Presented at annual meeting of the Nat'l. Acad. Sciences, Washington, D. C., Apr. 28-30, 1958.

Published in Science, v. 127: 1061, May 2, 1958.

In the early gold-rush days of quantum mechanics, the effort of theoretical physicists was largely concentrated in applying the new theory to the problem of the basic structure of atoms, molecules, solids, and liquids. Great advances were made, but quantitative progress toward understanding the electronic structure of extranuclear matter was frustrated for all but the simplest cases by the immensely complicated and laborious computations needed. The development of computationally practicable expressions for certain very difficult integrals has gone far recently toward breaking this computational bottleneck. A still more important new factor has been the programming for large electronic digital computers of the otherwise still excessively time-consuming numerical computation of these integrals. In our laboratory, machine programs have been completed for this purpose and for additional steps needed to obtain fairly good molecular wave functions for simple molecules. With these wave functions available, various molecular properties can be computed, and fundamental understanding of molecular and solid structures and of intermolecular forces can be advanced immensely. Computations on radicals, ions, and excited and activated states of molecules, which often are experimentally little accessible, will be especially valuable. We in this laboratory are now working in these directions. We believe the investigators in this field have crossed the threshold of a new era in the application of quantum mechanics to molecular physics and quantum chemistry.

CHI. 15:014

Chicago U. Lab. of Molecular Structure and Spectra, Ill.

IMPROVED MOLECULAR ORBITALS (COMPUTATIONS ON H_2), by P. E. Phillipson and R. S. Mulliken. [1958] [2]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-471 and National Science Foundation) Unclassified

Published in Jour. Chem. Phys., v. 28: 1248-1249, June 1958.

Molecular orbital calculations using LCAO approximations have been carried out for the singlet and triplet excited states of H_2 using six values of the internuclear distances. It has been found that by means of selecting separately adjustable values of the parameter ζ for each molecular orbit the LCAO approximations yield better than expected agreement with self-consistent field molecular orbitals.

CIN. 04:001

Cincinnati U. Applied Science Research Lab., Ohio.

MOLECULAR STRUCTURE OF EPOXY POLYMERS AS A BASIS FOR ADHESION, by H. Alter and W. Soller. Mar. 27, 1957 [29]p. incl. illus. diagrs. table, refs. (Technical rept. no. 1) (AFOSR-TN-57-279) (AF 18(600)1141) AD 126580 Unclassified

Also published in Indus. Engineering Chem., v. 50: 922-927, June 1958. (Title varies)

The adhesion properties of epoxy polymers were studied by means of the Cincinnati ultracentrifugal adhesion tester. The procedure involved dissolving Shell Epon 1001 in a mixture of organic solvents and curing the solution with amine curing agents. Samples of the polymer solution were dried, baked, and used to coat the replicate rotors of the ultracentrifuge. The rotors were made of 4340 steel and treated to yield a hardness of 50 to 52 Rockwell C. Before coating, the rotors were highly polished to effect the smooth surface desirable for a strong joint. The results indicated that in certain cases, adhesion was independent of the initial concentration of the polymer and of the extent of cure when coated, and that there was a minimum of adhesion at a viscosity of about 400 centipoise. The results of coating at constant polymer concentration with changing chain length indicated that adhesion decreased sharply with viscosity if the viscosity increase was due to the increasing chain length. If the chain length was constant and the concentration was increased, the adhesion increased with viscosity. Adhesion was inversely proportional to the amine content and could be changed by as much as 200 to 300 psi by changing the structure of the cured mass. Adhesion increased greatly when diethylene triamine was replaced by hexamethylene diamine as the curing agent, because the latter increased the flexibility of the cured polymer. A study of the isotherms of Frisch (Jour. Phys. Chem., v. 57: 584, 1953, *ibid.*, v. 58: 507, 1954) and of Hobden and Jellinek (Jour. Polymer Science, v. 11: 356, 1953) indicated similarities between the factors governing adsorption and adhesion. (Contractor's abstract)

CIN. 02:002; CME. 01:001;
COL. 01:004; COL. 02:006

CIN.02:002

Cincinnati U. Applied Science Research Lab., Ohio.

STUDIES OF THE DIELECTRIC PROPERTIES OF INSULATING LIQUIDS, by J. Winslow and M. Ish-Shalom. Final rept. May 15, 1958, 54p. incl. diagrs. tables, refs. (AFOSR-TR-58-66) (AF 18(600)1318) AD 158273

Unclassified

In view of the results of the experiments described in this report, two definite conclusions can be stated: (1) that the Davidson-Cole equation has broad application in the field of glassy state dielectric dispersion; and (2) that the favorite whipping boy for deviations from Debye behavior, namely dipole-dipole interactions, may not be blamed here. The first of these conclusions cautions investigators against accepting sparse data as indicating either the Debye equation or the Cole-Cole equation, since positive differentiation between these and the Davidson-Cole equation is difficult unless the manner in which the Cole-Cole plot approaches the axis of reals at ϵ_0 and ϵ_∞ is known. Judging from the materials investigated to date this involves measurements over a frequency range extending at least two decades on either side of the frequency corresponding to maximum loss factor. The second conclusion suggests that advancement of the general theory will best be served by turning consideration from detailed effects of local structure on the local field, and toward other approaches, such as the solution of the equations arising from Fröhlich's model when the frequency of activating collisions is not large compared to that of the applied field.

CME.01:001

College of Medical Evangelists. School of Tropical and Preventive Medicine, Loma Linda, Calif.

REPORT OF A PRELIMINARY SURVEY ON THE HA TRIBE OF TANGANYIKA, EAST AFRICA, PART II, by S. A. Farag, K. C. Fischer and others. Oct. 21-Dec. 23, 1957, 1v. incl. illus. diagrs. tables. (AF 49-638)267

Unclassified

A survey was made to determine the following existing conditions regarding the aboriginal Ha tribe of Tanganyika, East Africa, in order to facilitate the development of a research and assistance program designed to raise the health standards of these people: (1) health knowledge of the people; (2) health status; (3) dietary habits; (4) sanitation and housing; (5) water supply; (6) waste disposal; (7) personal hygiene; (8) maternal and child health and hygiene; (9) chief diseases and their etiology and epidemiology; and (10) natural products used in the treatment of diseases by the natives, their botanical sources, clinical and anthropological data regarding their use, and observations on their effectiveness. The survey report includes suggestions and recommendations regarding means to provide health

education, better diets, improved water, sanitation, and living habits, better medical care, methods for eliminating sources of disease, and improved treatment of diseases.

COL.01:004

Colorado U. Dept. of Chemistry, Boulder.

THE PREPARATION OF DIELS-ALDER POLY ADDUCTS CONTAINING NITROGEN AND OXYGEN, by J. S. Meek, P. A. Argabright and others. Final and technical rept. Feb. 1957, 129p. incl. diagrs. tables, refs. (AFOSR-TR-57-21) (AF 18(600)648) AD 120473

Unclassified

Double dienes and double dienophiles have been found to be capable of giving polymers in the Diels-Alder reaction. Most of the polymers were very insoluble materials with high softening or decomposition points. Their insolubility prevented molecular weight studies save in a few cases where probably lower molecular weight material was involved. In such cases the molecular weights were about 3,000. The bis-maleimides prepared for making the polymers were found to be cross linking agents in free radical copolymerizations although they have not been polymerized by themselves. Tetrachlorofulvenes were discovered to be inert in the Diels-Alder reaction. When p-6(1,2,3,4-tetrachloro)fulvylphenyl p'maleimidobenzoate was prepared the compound did not react with itself to give a polymer as hoped but was perfectly stable. It was red in color due to the fulvene structure and copolymerization with vinyl acetate gave a beautiful red polymer due to the polyfulvene units in the chain. Use of this compound and others like it to give colored copolymers is suggested. Many hitherto unknown compounds have been prepared in the course of this investigation. Samples of the bis-maleimides have been requested by Dr. Howard Bond of the U.S. Public Health Service for testing against cancer and some of these have been supplied. This type of compound is considered to be potentially good and the Public Health Service is starting a research program elsewhere solely to produce bis-maleimides for cancer testing.

COL.02:006

Colorado U. [Dept. of Chemistry] Boulder.

REACTION CALORIMETRY: THE HYDROGENATION OF ORGANIC FLUORIDES AND CHLORIDES, by J. R. Lacher and J. D. Park. Oct. 10, 1957, 12p. incl. tables. (Technical note no. 7) (AFOSR-TN-57-430) (AF 18(600)-1151) AD 136419

Unclassified

The hydrogenations of some alkyl fluorides, chlorides, and bromides were studied with a catalyst consisting of PD on activated charcoal. Iso-PrF was quantitatively hydrogenated at 155°C to give C_3H_8 and HF. PrF was more difficult to hydrogenate. When a new and active catalyst was used, the reaction was quantitative at

COL.02:007 - COL.02:010

temperatures of 190°C and above. The maximum conversion of MeF and EtF to CH_4 and C_2H_6 was 10% at 240°C. At 240°C, 99.5% of MeCl was converted to CH_4 and HCl. Both EtCl and vinyl chloride hydrogenated easier than MeCl. MeBr, EtBr, PrBr, and iso-PrBr hydrogenated readily at 240°C. Catalytic hydrogenation of some simple olefins containing F, Cl, and Br occurred at a lower temperature than those involving the alkyl halides by being quantitative between 100° to 130°C. 1, 1-dichloro-2,2-difluoroethylene was reacted with H in a 1:5 molar ratio of 90°, 120°, 180° and 240°C. The reaction product formed at 90°C contained a small amount of a high-boiling material which could not be identified. The product at 120°C distilled over at -25°C; only a trace of high-boiling material was present. At 180° and 240°C, small amounts of HF were produced. After distillation, the materials obtained at 180° and 240°C contained 99.4 and 97.1% CF_2HCH_3 , respectively.

A second component boiling at -84°C was obtained. In a second series of runs at 120°C, a deficiency of H was used and the ratio of H to organic was varied. The substitution of H for Cl occurred before the H added to the double bond; no $\text{CF}_2\text{H-CH}_3$ was formed. Cl which is attached to an unsaturated C atom can be more readily substituted than if a saturated compound is involved.

COL.02:007

Colorado U. [Dept. of Chemistry] Boulder.

THE KINETICS OF THE VAPOR-PHASE PHOTO-CHLORINATION OF TRIFLUOROCHLOROETHYLENE, by D. L. Bunbury, J. R. Lacher, and J. D. Park. Oct. 1, 1957 [13]p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-57-470) (AF 18(600)1151) AD 136644 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 5104-5107, Oct. 5, 1958.

The kinetics were investigated of the photochemical addition of Cl to chlorotrifluoroethylene. A manometric method was employed to indicate the progress of the addition reaction. The dependency on the rate of light intensity and the partial pressure of the reacting substances was measured in the presence of O. Cl and tri-fluoroethylene reacted spontaneously in the dark. (Contractor's abstract)

COL.02:008

Colorado U. Dept. of Chemistry, Boulder.

REACTION HEATS OF ORGANIC HALOGEN COMPOUNDS. IX. THE CATALYTIC HYDROGENATION OF VINYL AND PERFLUOROVINYL BROMIDE, by J. R. Lacher, A. Kianpour and others. [1957] [2]p. incl. tables. (AF 18(600)1151) Unclassified

Published in Jour. Phys. Chem., v. 61: 1125-1126, Aug. 1957.

This paper deals with the catalytic hydrogenation of vinyl bromide and perfluorovinyl bromide. In the case of vinyl bromide, the reaction was quantitative, and calorimetric measurements could be carried out. In the case of the perfluoro compound, the activity of the catalyst varied. Initially the catalyst was sufficiently active to replace the bromine and saturate the double bond. With increasing use, it would continue to replace the bromine, but it would become less effective in saturating the double bond. Accurate calorimetric data could not be obtained.

COL.02:009

Colorado U. Dept. of Chemistry, Boulder.

REACTION HEATS OF ORGANIC HALOGEN COMPOUNDS. X. VAPOR PHASE HEATS OF HYDROBROMINATION OF CYCLOPROPANE AND PROPYLENE, by J. R. Lacher, A. Kianpour, and J. D. Park. [1957] [2]p. incl. tables. (AF 18(600)1151) Unclassified

Published in Jour. Phys. Chem., v. 61: 1124-1125, Aug. 1957.

The vapor phase heats of hydrobromination of propylene and cyclopropane have been redetermined. For propylene a value of -20,430 cal/mol agrees well with that of -20,140 previously reported. For cyclopropane the value of -25,790 cal/mol is 3100 cal more exothermic than that previously reported. (Contractor's abstract)

COL.02:010

Colorado U. Dept. of Chemistry, Boulder.

REACTION HEATS OF ORGANIC HALOGEN COMPOUNDS, by J. R. Lacher and J. D. Park. [May 15, 1958] [15]p. incl. illus. tables, refs. (AFOSR-TN-58-413) (AF 18(600)1151) AD 158216 Unclassified

The energy necessary to carry out the following halogen reactions has been measured: (1) heat of formation of HCl and HBr in an atmosphere of excess H gas; (2) heat of chlorination of 7 fluorine-containing olefins in an atmosphere of excess olefin, in which the C = C bond was converted to a single bond; (3) hydrogenation of 4 simple alkyl halides; and (4) hydrobromination of some simple olefins. Strong deviations from an additivity rule has been observed for measurements in group (2). The heat of isomerization of three isomeric butenes has been calculated from (4) and found to agree with Kistiakowsky's hydrogenation data.

COL. 02:011; COL. 05:001;
COL. 06:001; COU. 18:001

COL.02:011

Colorado U. Dept. of Chemistry, Boulder.

THERMOCHEMICAL AND PHOTOCHEMICAL STUDIES ON ORGANIC FLUORINE COMPOUNDS, by J. L. Bitner, D. L. Bunbury and others. Final rept. Aug. 5, 1958, 189p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-99) (AF 18(800)1151) AD 162198; PB 138732

Unclassified

Thermochemistry of organic halogen compounds: Catalytic hydrogenation reactions were performed on $\text{CClF}_2\text{CClF}_2$, CClF_2CF_3 , CCl_2F_2 and $\text{CCl}_2\text{FCClF}_2$. A few experiments were conducted on the hydrogenation of CH_3Cl and CH_2Cl_2 . An instrument which was constructed for the chromatographic analysis of gaseous products consisted of a carrier gas flow system, sampling system, chromatography columns, the sensing system. Each reaction was tested in a pilot plant in order to determine the nature and activity of a suitable catalyst, the correct rate of flow and optimum proportion reactants, and the best temperature. Photochemical studies: The polymerization of olefinic compounds was studied under the influence of UV light. The rate of the photochemical addition of Cl to trifluorochloroethylene was investigated at 3 different temperatures; a mechanism is proposed for the reaction at room temperature. Experiments were conducted on the reaction between Cl, O, and $\text{CF}_2 = \text{CFCI}$, which appeared to be a chlorine-sensitized oxidation of the olefin. The experiments were made in both static and flow systems. The gaseous mixtures appeared to undergo a rapid reaction in the dark with the production of light. The photobromination of trifluorobromoethylene was also studied. Preparation of organic compounds: Preparations are discussed of the compounds for calorimetric and photochemical studies and those prepared for the Bureau of Mines, the latter including benzyl fluoride, m-trifluoromethyl benzoic acid, and the 2,2'- and 4,4'-difluorobiphenyls.

initial state of strain can be estimated from geometrical considerations. The principle of the straining mechanism, its construction, and its use in the measurement of strain birefringence is described. (ASTIA abstract)

COL.08:001

Colorado U. [Dept. of Mathematics] Boulder.

ON PARABOLIC CONVERGENCE REGIONS FOR CONTINUED FRACTIONS, by W. J. Thron. [1958] 13p. (AFOSR-TN-58-289) (AF 49(838)100) AD 218710; PB 135988

Unclassified

Also published in Math. Zeitschr., v. 89: 173-182, 1958.

The author continues his study of parabolic convergence regions for continued fractions $a_1/1 + a_2/1 + \dots$. There is obtained an estimate of the error committed if the continued fraction is replaced by one of its approximants, a result which also gives information concerning the factors that influence the rapidity of convergence. A convergence neighborhood is found in which the convergence is proved uniform, even though the elements a_n are functions of any number of variables. Among other convergence theorems proved here, two results are established in which the a_n lie in different parabolas for different values of n. (Math. Rev. abstract)

COU.18:001

[Columbia U., New York]

GUIDANCE AND CONTROL. SECOND GUIDED MISSILES SEMINAR. Sept. 24-28, 1958, 391p. incl. illus. diagrs. refs. (NATO AGARDograph rept. no. 21) (AFOSR-TN-58-228) (AF 18(803)133) AD 154130

Unclassified

COL.05:001

Colorado U. Dept. of Chemistry, Boulder.

ANISOTROPIC PROPERTIES OF STRAINED VISCO-ELASTIC FLUIDS. I. A METHOD FOR MEASURING STRAIN BIREFRINGENCE, by S. J. Gill. Aug. 22, 1958 [19]p. incl. illus. diagrs. refs. (AFOSR-TN-58-762) (AF 49(838)310) AD 201861; PB 136752

Unclassified

Also published in Jour. Appl. Polymer Science, v. 1: 17-23, Jan.-Feb. 1959.

A new method for producing a temporary anisotropic state in viscous polymer solutions was developed. The method is based upon suddenly straining the material to a known extent and measuring the anisotropy and its decay by the induced birefringence. In this way the

The AGARD Guided Missiles Seminar was held in Venice, Italy. The topics dealt with ranged from the problems encountered in the selection of a missile guidance and control system to its final testing in actual flight. Twenty-four papers by different authors were presented. They include the following: weapons system philosophy, ORO weapon system philosophy, new principles in the design of superior communications, navigation, and missile guidance systems, guidance techniques, considerations in the choice of a missile guidance and control system, inertial navigation, aiding the inertial navigation system, linear homing navigation, pitfalls in missile control, the effects of airframe characteristics on control system design, geometrical stabilization based on servodriven gimbals and integrating gyro units, sampled-data systems, digital techniques in missile guidance systems, the use of digital computer techniques in missile design and control, the application of noise

COU.02:023 - COU.02:025

and filter theories to guidance problems, recent developments in fixed and adaptive filtering, practical problems encountered in missile guidance and control design, application of methods of science to the problem of reliability reliability of guided missiles, laboratory vs flight evaluation of airborne guidance components, trends in field testing of guided missiles, low signal level missile instrumentation, on the way to automated processing of flight measurement, and paper on the guidance and control of missiles.

COU.02:023

Columbia U. [Columbia Radiation Lab.] New York.

NUCLEAR MASS RATIOS AND MAGNETIC EFFECTS IN CO (Abstract), by B. Rosenblum and A. H. Nethercot, Jr. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, Atomic Energy Commission, and [Air Force Office of Scientific Research] under [DA 36-039-sc-64630])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 44, Jan. 30, 1957.

Nuclear mass ratios determined from molecular spectra must be corrected for the contribution of higher electronic states induced by the rotation of the molecule. This correction can be made through a measurement of the molecular magnetic moment. To this end, measurement of the rotational frequencies of six isotopic species of CO have been made to an accuracy of about 0.004 mc near 110 000 mc and measurements of the magnetic moment of four isotopic species to an accuracy of about 1/5%. The correction to the nuclear masses calculated from the magnetic moment reduces the discrepancy between the presently measured $C^{14} - C^{12}$ mass difference (the worst case) and the mass difference calculated from nuclear reaction data from approximately 300 micro-mass units to about 40 micro-mass units. This remaining discrepancy is far outside the errors involved. A preliminary investigation of the effects of higher order perturbations on the electrons fails to disclose any explanation for this anomaly.

COU.02:024

Columbia U. Columbia Radiation Lab., New York.

SOME MOMENTS OF RADIOACTIVE IODINE NUCLEI (Abstract), by P.[C.] Fletcher and E. Amble. [1957] [1]p. (Sponsored jointly by Signal Corps, Atomic Energy Commission, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64630])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 30, Jan. 30, 1957.

Approximately 1 μ g of I^{125} has been obtained by bombardment of tellurium by deuterons [$Te^{125}(d, 2n)I^{125}$ and $Te^{124}(dn)I^{125}$] and chemically synthesized into CH_3I^{125}

The absorption spectra of this molecule was then examined with a conventional Stark modulated microwave spectrometer. Five absorption lines have been observed which can be fitted into a quadrupole hyperfine structure pattern of the $J = 2 - 1$ rotational spectrum assuming a nuclear spin for the I^{125} of 5/2. The resulting quadrupole coupling constant is 2179.5 ± 1.0 mc, giving a ratio of quadrupole moments $Q_{125}/Q_{127} = 1.1270 \pm 0.0005$. The shift of the rotational frequency due to the isotopic substitution of I^{125} was 49.3 ± 5 mc in good agreement with that expected. The observed values of spin and quadrupole moment suggest a $d_{5/2}$ configuration for the ground state of the I^{125} nucleus similar to that of I^{127} . Preliminary measurements on the magnetic moment of I^{125} by Zeeman effects on the microwave spectrum also indicate this configuration. This technique is also being applied to determine the moments of other radioactive iodine nuclei.

COU.02:025

Columbia U. [Columbia Radiation Lab.] New York.

TWO-CAVITY MASER SPECTROMETER (Abstract), by A. Javan and T. C. Wang. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64630])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 209, Apr. 25, 1957.

A beam maser-spectrometer can be operated with two cavities. Microwave power is introduced into the first cavity and molecular emission is observed in the second cavity. The power emitted in the second cavity from a beam of uniform velocity distribution is

$$P = Nh\nu \left[\sin^2 \left(\frac{\mu_{12} E_1 \tau_1}{2\hbar} + \frac{\mu_{12} E_2 \tau_2}{2\hbar} \right) - \sin^2 \left(\frac{\mu_{12} E_1 \tau_1}{2\hbar} \right) \right]$$

where N is the beam intensity, E_1 and E_2 the amplitudes of the electric field in the first and second cavity, τ_1 and τ_2 the transit times. In this equation it is assumed that

COU.02:026 - COU.02:028

microwave frequency is at the resonance center. Hence, for small E_2 , P is proportional to E_2 . In contrast to this situation, in a one cavity system the emitted power is proportional to E^2 for small E . Now if the cavity loss is proportional to E^2 , it can be shown that in the latter case, a threshold value for N is necessary to obtain a self-sustained oscillation. However, in a two cavity system, radiation is obtained in the second cavity for any value of N . The main ammonia 3-3 line and its magnetic satellites are observed experimentally.

COU.02:027

[Columbia U. Columbia Radiation Lab., New York.]

FLUCTUATIONS IN AMPLIFICATION OF QUANTA WITH APPLICATION TO MASER AMPLIFIERS, by K. Shimoda, H. Takahasi, and C. H. Townes. [1957] [15]p. [Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-ac-64630] Unclassified

Published in Jour. Phys. Soc. Japan, v. 12: 686-700, June 1957.

Fluctuations in the amplification and absorption of waves by quantum processes are considered. Assuming for each quantum the probability (per unit time) a of producing another quantum, probability b of being absorbed, and assuming a probability c that a new quantum is introduced, a set of differential equations is obtained. By solving these equations, a complete expression for the probability of distribution of quanta is obtained, as well as expressions for the average values and fractional fluctuation. The expressions developed are applied in particular to maser-type amplifiers, and certain fluctuations in the amplification of electromagnetic waves are pointed out which are important when their quantum character becomes significant. This condition can occur in maser-type amplifiers, where thermal and extraneous noises may be very small. For such an amplifier, a is proportional to the number of excited molecules, whereas b consists of a term proportional to the number of molecules in the ground state plus terms due to certain other losses. The noise temperature of a maser-type traveling-wave amplifier is the "effective temperature"

$a(a-b)^{-1}h\nu/k$. In superregenerative and regenerative amplifiers using resonant cavities, the noise temperature is rather similar, if losses through the input coupling hole are excluded from b . In any case, the limiting noise for an ideal amplifier corresponds to a classical noise temperature of $h\nu/k$. (Contractor's abstract)

COU.02:028

Columbia U. [Columbia Radiation Lab.] New York.

THE QUADRUPOLE MOMENT OF O^{17} , by M. J. Stevenson and C. H. Townes. [1957] [3]p. incl. diagrams, tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-ac-64630]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 31, Jan. 30, 1957.

Also published in Phys. Rev., v. 107: 634-637, July 15, 1957.

COU.02:026

Columbia U. [Columbia Radiation Lab.] New York.

ELECTRONIC STRUCTURE OF OXYGEN BONDS IN MOLECULES (Abstract), by M. J. Stevenson. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-ac-64630]) Unclassified

Presented at Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 10-14, 1957.

Published in Symposium on Molecular Structure and Spectroscopy. Abstracts. 1957, p. 52.

The quadrupole hyperfine structure due to the O^{17} nucleus observed in microwave rotation spectra gives information on the bonds of various molecules containing oxygen. The value of the O^{17} quadrupole moment obtained from a measurement of the quadrupole coupling constant in HDO^{17} is $-.03 \pm .01 \times 10^{-24} \text{ cm}^2$, about six times greater than the value accepted thus far.

Therefore, the quadrupole spectrum of O^{17} should be resolvable in most molecules. The measurement of the hyperfine structure in the HDO^{17} rotational spectrum

yields $e \left(\frac{\partial^2 V}{\partial a^2} \right)_{\text{ave}} Q = -10.3 \text{ mc}$. A larger amount of

hybridization than previously expected is indicated by the small value of the asymmetry parameter $n = 4.72$. The molecular orbital calculations of Ellison and Shull will be compared with the experimental data. Nethercot and Rosenblum have obtained $eQ = +4.43 \text{ mc}$ for CO^{17} . This result is in disagreement with the MO calculations for CO, with the generally accepted valence bond picture of CO, and also with the measured eQ of OCS. Large amount of hybridization of the $2p\sigma$ oxygen orbital or

inclusion of π bonded $C^+ - O^-$ structure is necessary to obtain the experimental value of eQ in CO. A comparison of the experimental and theoretical data on several molecules containing oxygen will be made.

COU.02:029 - COU.02:033

The nuclear quadrupole hyperfine structure resulting from O^{17} has been measured by A. H. Nethercot, Jr., and B. Rosenblum in the rotational microwave spectrum of the molecule CO^{17} . They find a quadrupole coupling constant eQ which is positive in sign and appreciably larger than that found in OCS. Since neither its sign nor its magnitude can be reconciled with the present value of the quadrupole moment Q of O^{17} and accepted electronic structure of CO, the microwave spectrum of HDO^{17} is being investigated. Hyperfine structure in the rotational transition $2_{20} - 2_{21}$ has been observed. Its analysis should yield a determination of the quadrupole moment of O^{17} with more certainty than is allowed by the spectrum of OCS or CO because of the relative simplicity in the evaluation of field gradients from the electronic structure of HDO.

COU.02:029

Columbia U. [Columbia Radiation Lab.] New York.

RADIO-FREQUENCY ZEEMAN EFFECT IN O_2 , by J. M. Hendrie and P. Kusch. [1957] [8]p. incl. diagrs. tables, refs. [Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64630] Unclassified

Published in Phys. Rev., v. 107: 716-723, Aug. 1, 1957.

The molecular-beam magnetic resonance method has been used to study the Zeeman effect of the rotational states of O_2 . The ratio of the g-value of the rotational magnetic moment to that of the electron-spin moment was found to be $g_r/g_s = (6.08 \pm 0.74) \times 10^{-5}$. The ratio of the g-value of the unpaired-electron spin moments in O_2 to that of the free-electron spin moment was found to be $g_s(O_2)/g_s(\text{free}) = 1 - (190 \pm 13) \times 10^{-6}$. (Contractor's abstract)

COU.02:030

Columbia U. Columbia Radiation Lab., New York.

COMMENTS ON FREQUENCY-PULLING OF MASER OSCILLATORS, by C. H. Townes. [1957] [2]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64630]) Unclassified

Published in Jour. Appl. Phys., v. 28: 920-921, Aug. 1957.

In a beam-type maser oscillator the cavity tuning "pulls" the oscillation frequency from the resonance frequency

ν_0 of the molecules by an amount $(\nu - \nu_0) \propto f(n)$ which is of the order of unity, where n is the number of molecules entering the cavity per sec. For a Maxwellian distribution of velocities, Lelmer and Lamb (Stanford U. Microwave Lab. Rept. no. ML-311, 1956) showed that $(\nu - \nu_0)$ increases initially as n increases, but Helmer's experimental results do not confirm this. The author briefly discusses the physical origin of the increase in $(\nu - \nu_0)$ and indicates a possible reason for its non-observance.

COU.02:031

Columbia U. [Columbia Radiation Lab.] New York.

HYPERFINE STRUCTURE OF K^{39} IN THE 4P STATE, by P. Buck and I. I. Rabi. [1957] [4]p. incl. diagrs. tables. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64630) Unclassified

Published in Phys. Rev., v. 107: 1291-1294, Sept. 1, 1957.

The atomic-beam magnetic resonance method has been used to investigate the hyperfine structure of the 4P state of K^{39} . The apparatus and method of observation were similar to those used in previous experiments on sodium, rubidium, and cesium. For K^{39} , the magnetic-dipole interaction constant in the $4P_{1/2}$ state is $a_{1/2} = 28.85 \pm 0.3$ mc/sec, the electric-quadrupole interaction constant in the $4P_{3/2}$ state is $b = 2.8 \pm 0.8$ mc/sec, and the quadrupole moment is $(0.07 \pm 0.02) \times 10^{-24}$ cm². (Contractor's abstract)

COU.02:032

Columbia U. [Columbia Radiation Lab.] New York.

MEASUREMENT OF NOISE IN A MASER AMPLIFIER, by L. E. Alsop, J. A. Giordmaine, and others. [1957] [2]p. incl. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64630) Unclassified

Published in Phys. Rev., v. 107: 1450-1451, Sept. 1, 1957.

A superregenerative NH_3 -beam maser amplifier has an effective noise temperature of 30°K, 25 times that expected for ideal spontaneous emission.

COU.02:033

Columbia U. [Columbia Radiation Lab.] New York.

THEORY OF A THREE-LEVEL MASER, by A. Javan.

COU.02:034 - COU.02:037

[1957] [11]p. incl. diagr. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64630])

Unclassified

Published in Phys. Rev., v. 107: 1579-1589, Sept. 15, 1957.

In a three-level maser, a transition between two energy levels is saturated in order to produce an induced emission of power at a lower frequency corresponding to a transition between an intermediate energy level and one or the other of the two saturated levels. In this paper, certain effects are discussed which cannot be predicted from a theory in which the population differences alone are considered in this process. For instance, it is shown that, in some cases it is possible to obtain for the same system an induced emission of power at two frequencies given by the resonances between the intermediate energy level and both of the saturated levels. Also, it is shown that, even in the absence of inhomogeneous broadening of the spectral line, one can obtain a net induced emission at some portions of a resonant line and a net absorption of other frequencies within the line widths. Such effects become important even in early stages of saturation in cases where $T_1 = T_2$ which is true

for ordinary gaseous systems and individual spin systems in a majority of very dilute paramagnetic solids. A complete theory is discussed for a gaseous system and extended to two limiting cases of paramagnetic materials with $T_1 = T_2$ and $T_2 \ll T_1$ for each individual spin system.

Furthermore, it is shown that for a saturating field of fixed frequency, the integral of induced power over the entire line is in full agreement with the results of a semiclassical treatment in which the population differences alone are considered. Some remarks are made as to the practicability of certain systems of this type. (Contractor's abstract)

COU.02:034

Columbia U. Columbia Radiation Lab., New York.

ACCELERATION IN THE EXPANSION OF THE CRAB NEBULA, by F. M. Johnson and C. H. Townes. [1957] [3]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64630) Unclassified

Published in Astrophys. Jour., v. 126: 466-468, Sept. 1957.

The acceleration in the expansion of the Crab Nebula is determined here by comparing the presently measured rate of expansion and the mean rate of expansion of the nebula (Baade 1942; Mayall and Oort 1942).

COU.02:035

Columbia U. Columbia Radiation Lab., New York.

QUADRUPOLE COUPLING CONSTANT AND MOLECULAR

STRUCTURE OF CO^{17} , by B. Rosenblum and A. H. Nethercot, Jr. [1957] [2]p. (Sponsored jointly by Signal Corps, Office of Naval Research and Air Force Office of Scientific Research under [DA 36-039-sc-64630])

Unclassified

Published in Jour. Chem. Phys., v. 27: 828-829, Sept. 1957.

The hyperfine structure due to the O^{17} nuclear quadrupole moment has been observed in the $J = 0 \rightarrow 1$ rotational microwave spectrum of CO. The value of eqQ obtained is in strong disagreement with both simple valence bond and molecular orbital calculations. A brief discussion is given of the structure implied by both the experimental and theoretical values.

COU.02:036

Columbia U. [Columbia Radiation Lab.] New York.

ATOMIC BEAM MEASUREMENTS OF THE HFS OF HYDROGENIC ATOMS IN THE METASTABLE 2S STATE, by P. Kusch. [1957] 2p. [Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64630] Unclassified

Published in Proc. Conf. on Radio and Microwave Spectroscopy, Duke U., Durham, N. C. (Nov. 4-6, 1957), Washington, Office of Naval Research [1957] p. 1-2.

Two experiments are briefly discussed. The first of these has led to a determination of the hfs of hydrogen and deuterium in the 2S state. The second of these has led to a determination of the hfs of the He^{3+} in the 2S state.

COU.02:037

Columbia U. [Columbia Radiation Lab.] New York.

A SUMMARY OF PROGRESS IN MASER DEVELOPMENT AND SOME OBSERVATIONS ON PARAMAGNETIC RELAXATION AT LOW TEMPERATURE, by C. H. Townes. [1957] [4]p. incl. refs. [Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64630] Unclassified

Published in Proc. Conf. on Radio and Microwave Spectroscopy, Duke U., Durham, N. C. (Nov. 4-6, 1957), Washington, Office of Naval Research [1957] p. 63-66.

COU.02:038; COU.19:001, 002

Coherent amplification of an electromagnetic wave as a result of interaction with matter can be shown to be impossible if the matter is in thermal equilibrium at any positive temperature. For an ensemble of systems with discrete energy levels, such equilibrium implies: (1) the population of one energy level is greater than that of a second level if its energy is lower; and (2) random phases of the systems. If either of these requirements are violated, the ensemble becomes unstable, and interaction with an electromagnetic wave may allow the ensemble to give up energy to the wave through stimulated emission, thus amplifying the wave.

COU.02:038

Columbia U. Columbia Radiation Lab., New York.

FINE STRUCTURE OF SINGLY IONIZED HELIUM, by E. Lipworth and R. Novick. [1957] [15]p. incl. diagrs. tables, refs. (Sponsored jointly by National Science Foundation, Signal Corps, Office of Naval Research, and [Air Force Office of Scientific Research] under [DA 36-039-sc-64630; continued by DA 36-039-sc-73279])
Unclassified

Published in Phys. Rev., v. 108: 1434-1448, Dec. 15, 1957.

The separation in energy (S) between the $2^2S_{1/2}$ and $2^2P_{1/2}$ states of singly ionized helium has been measured to high precision by a microwave method. Helium atoms in a resonant cavity are excited to the $2^2S_{1/2}$

state of the ion by bombardment with 300-v electrons. Rf power is applied to induce transitions between the two states and the 40.8-ev photon which arises from the decay of the $2^2P_{1/2}$ state to the $1^2S_{1/2}$ ground state of the ion is detected by a photomultiplier tube. A method of synchronous detection is employed to improve the signal-to-noise ratio. Twenty-six determinations of (S) have been made under differing experimental conditions in an attempt to uncover sources of systematic error. The value of (S) obtained for He^+ is $14\,040.2 \pm 4.5$ mc/sec. The uncertainty is equal to three times the standard deviation plus an estimated 1.3 mc/sec for the uncertainty in various systematic corrections. The result is in agreement with previous determinations but differs significantly from the best available theoretical value of $14\,056.8 \pm 3.0$ mc/sec. It is shown that this discrepancy might be resolved, without impairing the excellent arrangement in hydrogen, by a theoretical relativistic term of the form $\alpha(\alpha Z)^6 \ln(\alpha Z)$. (Contractor's abstract)

COU.19:001

Columbia U. [Columbia Radiation Lab.] New York.

ISOTOPIC MASS RATIOS, MAGNETIC MOMENTS AND THE SIGN OF THE ELECTRIC DIPOLE MOMENT IN CARBON MONOXIDE, by B. Rosenbium, A. H. Nethercot, Jr., and C. H. Townes. [1958] [13]p. incl. diagrs. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-73279, continuation of DA 36-039-sc-64630])
Unclassified

Published in Phys. Rev., v. 109: 400-412, Jan. 15, 1958.

Precision measurements of the $J = 1 \rightarrow 0$ rotational frequencies and the molecular magnetic moments for various isotopic species of carbon monoxide have been made in order to determine isotopic mass ratios. A correction amounting to several hundred micromass units and evaluated from the magnetic moment has been applied for the fact that the electrons are not spherically distributed about their respective nuclei. It is also shown that the rapidly precessing electronic angular momentum causes a "wobbling" motion of the nuclei which in turn produces a stretching of the molecule ("wobble stretching") inversely proportional to the reduced mass of the molecule, but independent of J . This stretching cannot be accurately evaluated from theory and therefore appears to be the ultimate limitation on microwave determinations of mass ratios. This correction amounts to about 20 micromass units and is evaluated by the use of the nuclear reaction value for the $C^{14}-C^{12}$ mass ratio. The final mass ratios agree very closely with the nuclear reaction values. The sign of the electric dipole moment was determined from the relative magnetic moments of the several isotopic species and corresponds to the charge distribution, C^+O^- . This appears to be the first measurement of the sign of the electric dipole moment in any molecule. (Contractor's abstract)

COU.19:002

Columbia U. [Columbia Radiation Lab.] New York.

PARAMAGNETIC RELAXATION AT VERY LOW TEMPERATURES, by J. A. Giordmaine, L. E. Alsop and others. [1958] [10]p. incl. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-73279])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 9, Jan. 29, 1958.

COU.19:003 - COU.19:005

Published in Phys. Rev., v. 109: 302-311, Jan. 15, 1958.

A series of experiments using paramagnetic resonance at microwave frequencies and in the 1-4°K temperature range on $\text{Gd}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$, $\text{K}_3\text{Cr}(\text{CN})_6$, and $\text{Cu}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ indicate the following characteristics for their relaxation: (1) It is the lattice-bath relaxation which limits the total rate of relaxation. (2) The spin-lattice relaxation time is several orders of magnitude smaller than the normally observed values of T_1 . (3) Breadth of the lattice modes is very much larger than the width of the resonances in diluted crystals, and in particular, for 1% paramagnetic concentration of the Cu salt, the breadth is several hundred of megacycles/sec. (4) Breadth of the lattice modes increases with increasing concentration of paramagnetic centers. (5) Two nearby resonances are rapidly brought to the same effective temperature by exchange of energy through the lattice modes. (6) The relaxation time T_1 is dependent on crystal size. Some consequences of these results are also discussed.

COU.19:003

Columbia U. Columbia Radiation Lab., New York.

MICROWAVE SPECTROSCOPY ON ClCN USING MASER TECHNIQUES (Abstract), by P. Thaddeus, A. Javan, and A. Okaya. [1958] [1]p. (Sponsored jointly by Signal Corps., Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-73279])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 28, Jan. 29, 1958.

The rotational transition $J = 2 - 1$ has been observed for the molecule ClCN, using the maser techniques developed for ammonia. Since the population distribution of the molecules over the relevant quantum states is less favorable than for ammonia, a considerably more sensitive microwave detection system has been developed. The electric quadrupole coupling of the Cl and N produces a hyperfine structure for this transition; the observed line widths are of the order of 1.5 kc/sec. The detection system consists of a superheterodyne, phase sensitive amplifier with a band width of about one cycle. The power source is a stabilized klystron, swept at a slow rate over a range of about 10 kc/sec. A well stabilized klystron is essential for this type of spectroscopy. The klystron used has a long term stability sufficient for use with much narrower band widths, and a short term stability of better than 200 cycles/sec. In order to obviate the difficulties caused by the broadness of a conventional frequency standard marker, the frequencies of the observed lines are being measured using

the maser oscillation of the ammonia 3,3 inversion line as a standard. The measurements in progress will permit the calculation of the I-J coupling constant for the first time.

COU.19:004

Columbia U. [Columbia Radiation Lab.] New York.

MICROWAVE SPECTRA OF THE Tl, In, AND Ga MONOHALIDES, by A. H. Barrett and M. Mandel. [1958] [18]p. incl. diagrs. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research and Air Force Office of Scientific Research under [DA 36-039-sc-73279])
Unclassified

Published in Phys. Rev., v. 109: 1572-1589, Mar. 1, 1958.

The present experiment has yielded accurate information concerning the internuclear distances, rotational constants, vibration-rotation interaction constants, and the quadrupole coupling constants of the Tl, In, and Ga monohalides. The ionic character for diatomic halides involving Group IIIB elements is less than that for the alkali halides, in keeping with their greater electronegativity. The values of s character found for the Ga and In bonding orbitals, argue strongly for the presence of s-p hybridization in the ionic state. The quadrupole coupling data presented here show that the electronegativities of Tl, In, and Ga are the same and approximately equal to 1.4 which is in agreement with Gordy's values.

COU.19:005

Columbia U. [Columbia Radiation Lab.] New York.

SPIN AND QUADRUPOLE MOMENT OF I^{125} AND THE MAGNETIC MOMENT OF I^{131} , by P. C. Fletcher and E. Ambler. [1958] [3]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-73279])
Unclassified

Published in Phys. Rev., v. 110: 536-543, Apr. 15, 1958.

The spin and quadrupole moment of I^{125} have been determined by observations on the microwave absorption spectrum of $\text{CH}_3\text{I}^{125}$. Five absorption lines have been observed which fit the quadrupole hyperfine pattern of the $J = 2 - 1$ rotational spectrum. The measurements indicate a spin of 5/2 and a quadrupole coupling constant of -2179 ± 1 mc/sec. Using this and other properties of the CH_3I molecule, the quadrupole moment of I^{125} is calculated to be $-0.66 \times 10^{-24} \text{ cm}^2$. This spin and quadrupole moment suggest a nuclear configuration for I^{125} similar to that of stable I^{127} , i.e., predominantly

COU.19:006 - COU.19:008

$d_{5/2}$. The magnetic moment of I^{131} has been measured by observation of the Zeeman splitting of the $F = 9/2 - 9/2$ ($K=1$) hyperfine line of the $J = 2 - 1$ rotational spectrum of CH_3I^{131} . The magnetic moment is found to be 2.56 ± 0.12 nuclear magnetons. The observations also confirm the previous results of Gordy et al for the spin of I^{131} of $7/2$ and quadrupole coupling constant, $eQq = -974 \pm 1$ mc/sec. The magnetic moment measurement suggests a ground-state configuration similar to that of I^{129} which is predominantly $g_{7/2}$ in nature but with large admixture of other states. The significance of these results are discussed. (Contractor's abstract)

COU.19:006

Columbia U. [Columbia Radiation Lab.] New York.

RECENT DETERMINATIONS OF ATOMIC MASS RATIOS BY MICROWAVE SPECTROSCOPY, by B. Rosenblum, C. H. Townes, and S. Geschwind. [1958] [3]p. incl. table. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-73279]) Unclassified

Published in Rev. Modern Phys., v. 30: 409-411, Apr. 1958.

A review is presented of the atomic mass ratios of isotopes of H, C, O, S, and Rb as determined by microwave spectroscopic methods. A comparison is made of the experimental values and experimental corrections as based on theoretical considerations of the microwave, nuclear reaction, and mass spectra methods of determining mass ratios.

COU.19:007

Columbia U. [Columbia Radiation Lab.] New York.

DESCRIPTION OF A RAMAN TYPE TWO-LEVEL MASER (Abstract), by A. Javan. [1958] [1]p. [Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-73279] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 213, May 1, 1958.

In a two-level system, if two photons of different frequencies are present with their frequency difference close to the energy separation of the two levels, in the presence of proper types of matrix elements, a transition can take place from the lower level to the upper

level in which the larger frequency photon is absorbed and the lower frequency photon is emitted. In the reverse transition, the role of absorption and emission of the photons is interchanged. This process, in the presence of a positive temperature, will produce amplification at the lower frequency. This effect will be treated quantum mechanically, and the probability of the spontaneous emission entering in the noise figure of this type of amplifier will be derived. Also the formula for magnetic susceptibility at the amplifying frequency for a paramagnetic ion of spin $\frac{1}{2}$ in an external magnetic field will be presented. The theoretical and practical application of this system to special cases of ferrites and systems with electric or magnetic dipole transitions will be discussed.

COU.19:008

Columbia U. [Columbia Radiation Lab.] New York.

MOLECULAR BEAM STUDIES OF METASTABLE STATES OF MERCURY (Abstract), by W. Lichten and M. McDermott. [1958] [1]p. [Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-73279] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 186, May 1, 1958.

The atomic beam magnetic resonance method is being applied to measurements of the properties of the metastable electronic states of mercury. A beam of mercury atoms in the ground state is subjected to electron bombardment. A fraction of the atoms are excited to metastable states. All atoms are refocused upon a stop wire by the A and B deflecting magnets. Atoms undergoing a transition in the C region are defocused and strike a sodium coated secondary emission detector. The transitions $\Delta F = 0$, $\Delta m_F = \pm 1$ have been observed for the even isotopes and for all the hyperfine levels of the odd isotopes of mercury in the $(6s, 6p)^3P_2$ state. In particular, the signal to noise ratio in the single transition Hg^{201} , $F = 1/2$, $\Delta m_F = \pm 1/2$, indicates that measurements of the hfs are feasible. These measurements are in progress. Transitions $\Delta F = 0$, $\Delta m_F = \pm 1$ have been observed for another metastable state of mercury lying at higher energy, with $J = 3$, $g_J = 1.09 \pm 0.02$. These observations confirm an earlier report which indicated that the $(5d)^9(6s)^2 6p^3D_3$ state is metastable.

COU.19:009 - COU.19:012

COU.19:009

Columbia U. Columbia Radiation Lab., New York.

HYPERFINE STRUCTURE OF THE METASTABLE STATE OF SINGLY IONIZED HELIUM-3, by R. Novick and E. D. Commins. [1958] [19]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by National Science Foundation, Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-73279]) Unclassified

Published in Phys. Rev., v. 111: 822-840, Aug. 1, 1958.

The hfs splitting $\Delta\nu$ of the metastable state of singly ionized helium 3 is determined by an ion-beam method. The conventional inhomogeneous molecular-beams A and B fields are replaced by radio-frequency fields at 13 350 mc/sec. At this frequency transitions are preferentially induced between the $F = 1$ component of the $2^2S_{1/2}$ state and the short-lived $2^2P_{1/2}$ state. All those

ions which have made the transition decay immediately to the ground state. Thus, as the beam passes through such a field, state-selection is accomplished by selective quenching of the $F = 1$ metastable ions. Two types of detection have been used: photoelectric detection of the Lyman-alpha photons emitted in the second state selector, and metastable ion detection by the surface Auger effect. Eighty-six determinations of the hfs splitting have been made under a range of experimental conditions. The final result is $\Delta\nu = 1083.35499 \pm 0.00020$ mc/sec. This value is compared with the theoretical hfs splitting for a point nucleus, which includes the known electrodynamic, relativistic, and reduced-mass corrections, and which may be computed precisely,

since the atomic wave function of He^{3+} is hydrogenic and known exactly. The observed hfs splitting is smaller by 186 ppm than the theoretical value. This anomaly is attributed to the effects of finite nuclear and nucleon size, higher order radiative effects, and possibly also to nuclear interaction currents. Estimates are made of some of these effects. The hfs splitting $\Delta\nu(1s)$ of the ground state of He^{3+} is estimated on the basis of the present result to be $\Delta\nu(1s) = 8665.628 \pm 0.013$ mc/sec. The experimental result is also compared with the experimentally determined hfs splitting of the $1s2s (^3S_1)$ state of the He^3 atom. The ratio of these two quantities yields a precise estimate of the electronic charge density at the nucleus of the 2^3S_1 state of the He^3 atom. Finally, the monoenergetic nature of the ion beam has allowed observation of a new molecular beams resonance power sharpening effect. (Contractor's abstract)

COU.19:010

Columbia U. [Columbia Radiation Lab.] New York.

OBSERVATIONS USING A MASER RADIOMETER AT 3-cm WAVE LENGTH (Abstract), by L. E. Alsop, J. A. Giordmaine and others. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-73279]) Unclassified

Presented at 100th meeting of the Amer. Astronom. Soc., Madison, Wis., June 29-July 2, 1958.

Published in Astronom. Jour., v. 63: 301, Sept. 1958.

The results presented are consistent with the expected low noise characteristics of maser amplifiers and demonstrate the improvement in radiometer performance obtainable with maser pre-amplifiers. They also show the feasibility of applying maser techniques to radio astronomical observations.

COU.19:011

Columbia U. [Columbia Radiation Lab.] New York.

UPPER LIMIT TO THE MAGNETIC MOMENT OF He^6 , by E. D. Commins and P. Kusch. [1958] [5]p. incl. diagr. table. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-73279]) Unclassified

Published in Phys. Rev. Letters, v. 1: 208-209, Sept. 15, 1958.

The upper limit of the magnetic moment of He^6 , determined by a Stern-Gerlach type of experiment, is 0.16 n.m. It seems highly probable on experimental grounds that the spin of He^6 nucleus is indeed zero.

COU.19:012

Columbia U. [Columbia Radiation Lab.] New York.

DETERMINATION OF NUCLEAR QUADRUPOLE MOMENTS, by C. H. Townes. [1958] [77]p. incl. diagrs. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-73279) Unclassified

Published in Handbuch der Physik, v. 38/1: 377-453, 1958.

Since the two classes of phenomena involve quite different techniques and different theoretical approaches, they have been considered somewhat separately. Basic theory for interaction of nuclear quadrupole moments in atomic and molecular systems is the first to be presented,

COU.20:001 - COU.20:005

followed by a theoretical analysis of the many types of experiments which allow measurement of these interactions, and discussion of methods for evaluating quadrupole moments themselves from the measured coupling constant. The general theory of interactions between nuclear quadrupole moments and fast particles is then treated, and evaluation of quadrupole moments from measurement of such interactions are discussed. Actual numerical results of all determinations of quadrupole moments have been reserved for the final sections, where some of the determinations are discussed, and values of quadrupole moments are summarized and compared.

COU.20:001

Columbia U. [Columbia Radiation Lab.] New York.

NON-CONSERVATION OF PARITY, by B. Bleaney. June 1, 1957 [6]p. (AFOSR-TN-57-257) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1334, [Signal Corps and Office of Naval Research under DA 36-039-sc-64630]) AD 126555
Unclassified

Also published in *Nature*, v. 179: 1101-1102, June 1, 1957.

The results of 2 experiments intended to provide evidence for the "law" of conservation of parity are described, both of which involve the direction of emission of the products of decay of radioactive particles relative to the orientation of the intrinsic angular momentum or spin of these particles. Weak interactions, meson, hyperon, and beta decay are investigated in verifying the non-conservation of parity. The consequences are discussed.

COU.20:002

Columbia U. [Columbia Radiation Lab.] New York.

MOLECULAR COMPOSITION OF ALKALI HALIDE VAPORS, by R. C. Miller and P. Kusch. Dec. 19, 1955 [17]p. incl. diagrs. tables, refs. (AFOSR-TN-57-258) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1334, Signal Corps and Office of Naval Research under [DA 36-039-sc-64630]) AD 126556
Unclassified

Also published in *Jour. Chem. Phys.*, v. 25: 860-876, Nov. 1956.

An analysis of the velocity distribution of the molecules which escape through an ideal aperture from an isothermal enclosure has been made for ten alkali halides (CsCl, CsBr, RbCl, KCl, KI, NaF, NaCl, NaI, LiCl, and LiBr). It is found that there is a significant abundance of dimers in all cases except those of the cesium salts, and that an observable concentration of trimers occurs

for NaF, LiCl and LiBr. Observation of the relative abundances of the polymers as the temperature of the effusing gas and the pressure within the source is varied permits the determination of the energy of dissociation of the dimer into two monomers and of the trimer into a monomer and dimer. Numerical errors have been found in the calculated data which appear in table X and have been corrected and appear as an errata publication in *Jour. Chem. Phys.*, v. 27: 981, Oct. 1957. (Contractor's abstract, modified)

COU.20:003

Columbia U. [Columbia Radiation Lab.] New York.

RELATIVE DETECTION EFFICIENCY OF LiBr AND (LiBr)₂, by P. Kusch. Feb. 4, 1958 [4]p. incl. table.

(Rept. no. CU-17-58) (AFOSR-TN-58-102) (AF 18-(600)1334) AD 152010
Unclassified

Also published in *Jour. Chem. Phys.*, v. 28: 1075-1078, June 1958.

The relative efficiency for the production of positive ions when LiBr and (LiBr)₂ are incident on a hot oxidized tungsten wire has been determined. It is found that the ratio of the number of ions produced for the dimer and the monomer is 2.0 ± 0.1 which verifies the assumption that n ions are produced from an n-polymer. The effects arising from the long mean free paths of molecules in ovens used for such studies have been observed and are discussed. (Contractor's abstract, modified)

COU.20:004

Columbia U. [Columbia Radiation Lab.] New York.

ON THE POLYMERIZATION OF ALKALI HALIDES, by P. Kusch. [1958] [1]p. incl. diagr. (AFOSR-TN-58-103) (AF 18(600)1334) AD 152011
Unclassified

Also published in *Jour. Chem. Phys.*, v. 28: 981-982, May 1958.

Conflicting statements which have appeared in the literature on the presence of dimer lithium halides in the gaseous phase have been examined. It is concluded that the high concentration of dimers is possible only at pressures which are equal to the true vapor pressure of the halide. It is concluded that the negative reports on the existence of the dimers is not conclusive and that a high concentration of dimers is possible.

COU.20:005

Columbia U. Columbia Radiation Lab., New York.

FREE EVAPORATION OF ALKALI HALIDE CRYSTALS, by G. M. Rothberg, M. Eisenstadt, and P. Kusch. [1958]

COU.20:006 - COU.20:009

[11]p. incl. diagrs. tables, refs. (AFOSR-TN-56-460)
(AF 16(600)1334) AD 158267 Unclassified

Also published in Jour. Chem. Phys., v. 30: 517-527,
Feb. 1959.

A study has been made of the evaporation of alkali halide crystals directly into vacuum to determine (1) whether or not the velocity distribution of the evaporating molecules is Maxwellian, (2) the chemical composition of the vapor, and (3) the evaporation coefficients and heats of evaporation of the various molecular species. Single crystals of CsBr, CsI, LiF, and NaCl were used. The velocities of the evaporating molecules were analyzed by means of the rotating cylindrical velocity selector used by Miller and Kusch. It was found that within relatively narrow limits of error the velocity distributions were Maxwellian. The vapor of CsI was found to contain only monomers; the others contained polymers in abundances different from those found in saturated vapors. The heats of evaporation of NaCl monomers and dimers are, respectively, 61.7 ± 4.6 and 67.2 ± 4.6 kcal/mol, which yields heats of activation for evaporation of about 9 kcal/mol. Heats of activation also exist for LiF, but could not be determined from the data. The evaporation coefficients of the CsI and CsBr monomers are about 0.3; the evaporation coefficients of the polymers of NaCl and LiF are temperature dependent and are in the range 0.2 to 1. (Contractor's abstract)

COU.20:006

Columbia U. [Columbia Radiation Lab.] New York.

THE MOLECULAR COMPOSITION OF ALKALI FLUORIDE VAPOURS, by M. Eisenstadt, G. M. Rothberg, and P. Kusch. [June 1958] [37]p. incl. diagrs. tables. (AFOSR-TN-56-461) (AF 16(600)1334) AD 156266 Unclassified

Also published in Jour. Chem. Phys., v. 29: 797-804,
Oct. 1958.

The abundances of polymeric species of the alkali fluorides in the vapor phase and their dissociation energies have been determined by use of the method of Miller and Kusch. For LiF, NaF, KF, RbF, and CsF, the dissociation energies of the dimer are 56.9, 54.3, 47.6, 42.0, and 37.8 kcal/mol, respectively. For LiF the trimer was also observed, with a dissociation energy of 36.3 kcal/mol. When the salt is in equilibrium with its vapor at a temperature where the vapor pressure is 10^{-2} mm of Hg, the abundance of the dimer decreases in the sequence from LiF to CsF. The heats of sublimation for the various species were also found. (Contractor's abstract)

COU.20:007

Columbia U. [Columbia Radiation Lab.] New York.

NUCLEAR REORIENTATION SPECTRUM OF Li^7 IN THE GASEOUS MONOMERS AND DIMERS OF THE LITHIUM HALIDES, by P. Kusch. [1956] [6]p. incl. diagrs. refs. (AFOSR-TN-56-694) (AF 16(600)1334) Unclassified

Also published in Jour. Chem. Phys., v. 30: 52-57,
Jan. 1959.

The nuclear reorientation spectrum of Li^7 has been observed in all the lithium halides under conditions in which the degree of dimerization of the molecules is first low and then high. In each of the halides the two spectra have a qualitatively different appearance which can only be interpreted under the assumption that at least two different molecular species occur in the beam. An approximate resolution of the spectra into that of the monomer and that of the dimer may be made. Significant differences in both the internal magnetic and the electric quadrupole interactions occur for the monomer and the dimer. (Contractor's abstract)

COU.20:008

Columbia U. Columbia Radiation Lab., New York.

NEW METASTABLE STATE OF MERCURY, by W. Lichten. [1957] [2]p. incl. diagrs. table. (AFOSR-TN-56-696) (AF 16(600)1334) AD 162230 Unclassified

Also published in Phys. Rev., v. 109: 1191-1192, Feb.
15, 1958.

A state of Hg with an excitation potential of 9 v has been found to be metastable. It is most likely the $^3\text{D}_3$ state of the configuration $(5d)^9(6s)^2(6p)$. It is possible that other members of this configuration also are long-lived. The use of alkali metals as detectors for metastable atoms is discussed. (Contractor's abstract)

COU.20:009

Columbia U. [Columbia Radiation Lab.] New York.

ON CHEMICAL EQUILIBRIUM AMONG THE POLYMERS OF THE ALKALI HALIDES, by M. Eisenstadt, V. S. Rao, and G. M. Rothberg. Feb. 1959 [2]p. incl. diagrs. (AFOSR-TN-58-985) (AF 16(600)1334) AD 205913 Unclassified

Also published in Jour. Chem. Phys., v. 30: 604-605,
Feb. 1959.

The equilibrium ratio of dimer to monomer NaCl has been restudied by means of the use of a larger oven in

COU.03:016; COU.04:003;
COU.21:001-003

which chemical equilibrium can be thoroughly established. Previous results of about 18% dimer concentration have been confirmed and a new value of the dissociation energy of 47.9 ± 0.6 kcal/mol has been reported.

COU.03:016

Columbia U. Dept. of Chemistry, New York.

MICROWAVE STUDIES OF THE STRUCTURE OF CYCLOPROPYL DERIVATIVES, by J. P. Friend and B. P. Dailey. [1958] [6]p. incl. diagrs, tables, refs. (AF 18(600)1152) Unclassified

Published in Jour. Chem. Phys., v. 29: 577-582, Sept. 1958.

The microwave spectra of cyclopropyl chloride and cyclopropyl cyanide have been studied and rotational constants for the Cl^{35} and Cl^{37} molecules of the chloride and for the normal molecule and two deuterated species of the cyanide (the cis and trans forms of

$\text{CH}_2-\text{CHD}-\text{CH}-\text{CN}$) have been determined.

COU.04:003

Columbia U. Dept. of Chemistry, New York.

PARAMAGNETIC RESONANCE OF METHYL- AND CHLORO-SUBSTITUTED p-BENZOSEMIQUINONES, by B. Venkataraman, B. G. Segal, and G. K. Fraenkel. Oct. 16, 1958, 37p. incl. tables, refs. (Rept. no. CU-15-58-AF-1390-Chem.) (AFOSR-TN-58-905) (AF 18(600)1390) AD 204430; PB 140317 Unclassified

Also published in Jour. Chem. Phys., v. 30: 1006-1016, Apr. 1959.

Detailed measurements were made under conditions of high resolution on the paramagnetic resonance spectra of the negative radical ions of all the methyl- and chloro-substituted p-benzosemiquinones. All the spectra exhibited hyperfine structure which is accounted for in terms of interactions between the unpaired electron and all the protons in the radicals. No chlorine hyperfine splittings were observed. In some of the chlorine compounds anomalous lines, not attributable to the chloro-substituted p-benzosemiquinone ion, appeared. Microwave power saturation was encountered in all the spectra examined. Line widths of all the spectra were observed to depend markedly on the microwave power and on the concentration of the hydroquinone from which the semi-quinone was prepared. Separations of the hyperfine components were measured to a high degree of accuracy. Splitting constants for individual protons were calculated from measurements using the

method of least squares. The variation of the splitting constants with chlorine and methyl-group substitutions are shown to obey a nearly additive relation. (Contractor's abstract)

COU.21:001

Columbia U. Dept. of Electrical Engineering, New York.

CORRELATION FUNCTION AND POWER SPECTRA OF SCATTER PROPAGATION LINKS FOR ARBITRARY INPUTS, by D. S. Bugnolo. June 2, 1958, 13p. incl. diagrs. (Technical rept. no. T-1/C; rept. no. CU-1-58AF350-EE) (AFOSR-TN-58-463) (AF 49(638)350) AD 158270; PB 136271 Unclassified

The correlation function and corresponding power spectrum of an electromagnetic wave scattered by the atmosphere is related to the power spectrum of the source by a generalization of the notions of time variable linear networks. The power spectrum of the received signal is regarded as the output of a system characterized by a tensor of the fourth rank. (Contractor's abstract)

COU.21:002

Columbia U. Dept. of Electrical Engineering, New York.

FIDELITY OF A COMMUNICATION SYSTEM AFFECTED BY ATMOSPHERIC TURBULENCE WITH APPLICATION TO LONG LINE-OF-SIGHT RADIO LINKS, by D. S. Bugnolo. Oct. 27, 1958 [24]p. incl. diagrs. refs. (Technical rept. no. T-2/C; rept. no. CU-3-58AF350-EE) (AFOSR-TN-58-968) (AF 49(638)350) AD 205603; PB 138742 Unclassified

The fidelity or mean squared error of a communication system affected by atmospheric turbulence is considered in detail. In particular the results of a general analysis are applied to the special case of a band-limited, long-line-of-sight radio link. Results show that the fidelity or mean squared error is directly proportional to band width. (Contractor's abstract)

COU.21:003

Columbia U. Dept. of Electrical Engineering, New York.

CORRELATION FUNCTION AND POWER SPECTRA OF RADIO LINKS AFFECTED BY RANDOM DIELECTRIC NOISE, by D. S. Bugnolo. [Nov. 3, 1958] [5]p. incl. diagrs. refs. (Technical rept. no. T-3 Sup.; rept. no. CU-4-59AF350-EE) (AFOSR-TN-58-968a) (AF 49(638)350) AD 220409 Unclassified

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-7: 137-141, Apr. 1959.

COU.21:004; COU.06:023, 024

The correlation function and corresponding power spectrum of an electromagnetic wave affected by random dielectric noise is related to the power spectrum of the source by an extension of the notions of time-variable linear networks. It will be shown that in general, the power spectrum of the received signal can be regarded as the output of a network characterized by a time-variable transfer function. The results are applied to a long line of sight radio link and used to predict the error in the received signal in a mean squared sense. This will be used to show that the rate of a source is bounded such that there exists a maximum rate R given a bandwidth δ and scattering parameters of the atmosphere. (Contractor's abstract)

COU.21:004

Columbia U. [Dept. of Electrical Engineering] New York.

MULTIPLE SCATTERING OF ELECTROMAGNETIC RADIATION AND THE TRANSPORT EQUATION OF DIFFUSION (Abstract), by D. S. Bugnolo. [1958] [1]p. [AF 49(638)350] Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., Apr. 23-26, 1958.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-6: 310, July 1958.

Multiple scattering of electromagnetic radiation by atmospheric and ionospheric turbulence is of considerable importance in long line-of-sight paths. The usual single scatter or Born approximation is of questionable value in such cases. Higher order Born approximations usually lead to equations of unusual complexity incapable of exact solution. Another possible method of solution is the transport equation of particle (photon) diffusion. The results of a single scatter or Born approximation can be used to construct an integral-differential equation in a six-dimensional phase space plus time. This method is of particular use in unbounded regions. The introduction of boundary conditions is usually untenable since the approximation is essentially scalar and the boundary conditions vector. The transport equation will be reviewed briefly and applied to a number of rather interesting long line-of-sight problems.

COU.06:023

Columbia U. [Dept. of Mathematical Statistics] New York.

DISCONTINUOUS MARKOFF PROCESSES, by J. E. Moyal. Apr. 1957, 55p. refs. (AFOSR-TN-57-535) (AF 18(600)442) AD 136521 Unclassified

Also published in Acta Math., v. 98: 221-264, 1957.

Consider a non-homogeneous Markov process $\xi(t)$ and a sequence of jump times $0 = \tau_0 < \tau_1 < \dots$. Let x, X

denote resp. a point and a set in the state space, $n \geq 0$,

$$x(X, t|x_0, t_0) = \Pr\{\xi(t) \in X | \xi(t_0) = x_0\},$$

$$x_n(X, t|x_0, t_0) = \Pr\{\eta \leq t \leq \eta_{n+1} | \xi(t_0) = x_0\},$$

$$\psi_n(X, t|x_0, t_0) = \Pr\{\eta_n \leq t; \xi(\eta_n + 0) \in X | \xi(t_0) = x_0\}.$$

We have then

$$(*) \quad x(X, t|x_0, t_0) = x_0(X, t|x_0, t_0) + \int x(X, t|x, \tau) \psi_1(dx, d\tau|x_0, t_0).$$

Noting that x_0 is the probability of transition without

jump, we see that the well-known development by Feller (Trans. Amer. Math. Soc., v. 48: 488-515 (1940)) corresponds to the case where there is no change of state without a jump, so that x_0 is of a specifiable form. Observe

that these so-called "jumps" may be of a prescribed kind and need not include all ordinary jumps (of the sample function). The main point of the paper is to show that part of Feller's theory can be carried over painlessly (except for notations and formalities) to the present generality. E.g., we have $x_n = x_j * \psi_{n-j}$ in understandable

notation, and $x_R = \sum_{n=0}^{\infty} x_n$ can be obtained by the same

iterative procedure and represents a solution of (*) except that it may be "incomplete". In the latter case not all possible transition is via a finite number of jumps and Doob's continuation procedure [Trans. Amer. Math. Soc., v. 58: 455-473, 1945] can also be applied, etc. Because the presentation is analytical the scope of processes covered is not delineated. (Math. Rev. abstract)

COU.06:024

Columbia U. [Dept. of Mathematical Statistics] New York.

TIGHTENED MULTI-LEVEL CONTINUOUS SAMPLING PLANS, by C. Derman, S. Littauer, and H. Solomon. [1957] [10]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)442] and Office of Naval Research) Unclassified

Published in Ann. Math. Stat., v. 28: 395-404, June 1957.

The following generalizations of an inspection plan by Sieberman and Solomon (Ann. Math. Statistics, v. 26: 686-704, 1955) for continuous production are considered. The j th sampling level is said to be in use of every

(f^{-1}) th item is sampled. If i successive inspected items are free of defects, one adopts a higher level of sampling; if one defective item is found, one adopts a lower level of sampling. The previous paper moved sampling from the j th to the $(j+1)$ st or $(j-1)$ st level, while here one can move it to the $(j+s)$ th or, on the other hand, to either the $(j-r)$ th or the zeroth level (= 100% inspection). Most of

COU.06:025-029; COU.22:001

the paper is devoted to calculating the AOQ (average outgoing quality=fraction defective after sampling) in terms of the fraction defective in the original production process and to calculating the AOQL (average outgoing quality limit=maximum possible fraction defective after sampling) in terms of the parameters of the plan, always assuming that the process is in statistical control. The results follow from certain properties of Markov chains. (Math. Rev. abstract)

COU.06:025

Columbia U. [Dept. of Mathematical Statistics] New York.

SOME CASES OF OPTIMALITY OF THE (s,S) POLICY, by A. Dvoretzky. Sept. 1957, 5p. (AFOSR-TN-58-9) (AF 18(600)442) AD 148048 Unclassified

Loss functions are given for which there exist optimal two-level ordering policies (s,S) in one-stage inventory problems with arbitrarily specified distribution of demand. (Contractor's abstract)

COU.08:028

Columbia U. [Dept. of Mathematical Statistics] New York.

ON THE WEAK LAW OF LARGE NUMBERS, by C. Derman. Oct. 1958 [2]p. [Rept. no. CU-40-58] (AFOSR-TN-58-155) (AF 18(600)442) AD 152181 Unclassified

A counterexample is used to show the incorrect nature of the alternate condition used by Loève and Gnedenko-Kolmogorov for the third necessary and sufficient condition that a sequence of independent random variables obey the law of large numbers.

COU.06:027

Columbia U. [Dept. of Mathematical Statistics] New York.

SEQUENTIAL ESTIMATION OF THE MEAN OF A NORMAL POPULATION, by H. E. Robbins. Aug. 1958, 15p. incl. tables. (Rept. no. CU-43-58) (AFOSR-TN-58-800) (AF 18(600)442) AD 202233 Unclassified

Presented at meeting of the Inst. of Math. Stat., Atlantic City, N. J., Sept. 10-13, 1957.

Also published in Probability and Statistics; The Harald Cramer Volume, Stockholm, Almqvist and Wiksell, 1959, p. 235-245.

The problem is considered of estimating the unknown mean μ of a normal population when the variance

σ^2 of the population is also unknown. As estimator the sample mean \bar{X}_n of a sample of size n is used, so that the problem is simply that of choosing n . In particular two rules for determining n sequentially are considered.

COU.08:028

Columbia U. [Dept. of Mathematical Statistics] New York.

PERFECT PROBABILITY SPACES, by G. Kallianpur. Sept. 1958, 1v. incl. refs. (Rept. no. CU-45-58) (AFOSR-TN-58-808) (AF 18(600)442) AD 202353; PB 140371 Unclassified

The drawbacks in the theories developed for probability spaces, such as the failure of a conditional probability distribution in association with the conditional probability of F-sets taken with respect to A, the non-valid nature of Kolmogorov's definition of a probability measure in infinite dimensional product space for arbitrary factor spaces and the non-equivalence of two seemingly identical definitions of the independence of random variables. Contents include sections on the following: The basic theorems of perfect probability measures; Perfection and independence of random variables; Perfect measure and conditional probability distributions; Perfect measures on product spaces and; A characterization of perfect space and some models of perfect probability spaces.

COU.08:029

Columbia U. [Dept. of Mathematical Statistics] New York.

SYNTHESIS OF MARKOFF CHAINS, by P. Frank. Sept. 3, 1958, 6p. (Rept. no. CU-44-58) (AFOSR-TN-58-809) (AF 18(600)442) AD 202354 Unclassified

Countable set (s) Markoff chains and the transitions

$S_{P_{ij}}$ are defined for all i and $j \in S$ with $S_{P_{ij}} \geq 0$ and $\sum_{j \in S} S_{P_{ij}} = 1$ for all $i \in S$. $T^{P_{ab}}$ is substituted for $\sum_{n=0}^{\infty} S_{P_{ab}}^{(n)} z^n$ and TU_x for $TU(x)$. Six formulas are presented with proofs and discussion.

COU.22:001

Columbia U. [Dept. of Mathematics] New York.

ON THE LUSTERNIK-SCHNIRELMANN CATEGORY OF ABSTRACT GROUPS, by S. Eilenberg and T. Ganea. [1957] [2]p. [AF 18(603)67] Unclassified

Published in Ann. Math., v. 65: 517-518, May 1957.

COU.22:002; COU.08:002;
COU.10:018, 019

This paper is a statement of results relating the dimension, category, and geometric dimension of a group. If Π is a group, then Π is of dimension n if the cohomology

group $H^q(\Pi; A) = 0$ for $q > n$, where A is any Π module, and n is the least such integer. Let $K(\Pi)$ be a connected CW-complex such that $\pi_1(K(\Pi)) = \Pi$ and $\pi_q(K(\Pi)) = 0$

for $q > 1$, i.e., $K(\Pi)$ is a connected aspherical CW-complex with Π as fundamental group. The homotopy type of $K(\Pi)$ is an invariant of the group Π . The category of Π is defined to be the category of the complex $K(\Pi)$. The authors' definition of category differs from the usual one. They say that X is of category n , if n is the least integer such that X may be covered by open sets U_0, \dots, U_n such that each U_i is contractible in X . If no such integer exists, then the category of X is ∞ . Note that this is just the usual definition of category $n + 1$. Finally, the authors define the geometric dimension of a group Π as the least integer n for which there is a connected aspherical CW-complex $K(\Pi)$ with Π as fundamental group which is of dimension n . Otherwise the geometric dimension of Π is ∞ . The main theorem of the paper is as follows. For any group Π

$\dim \Pi = \text{category } \Pi = \text{geom. dim } \Pi$
except possibly for the following three cases:

	A	B	C
dim	1	1	2
category	2	2	2
geom. dim	2	3	3. (Math. Rev. abstract)

COU.22:002

Columbia U. Dept. of Mathematics, New York.

ON THE DIMENSION OF MODULES AND ALGEBRAS, VIII. DIMENSION OF TENSOR PRODUCTS, by S. Eilenberg, A. Rosenberg, and D. Zelinsky. [1957] [23]p. incl. refs. (AF 18(603)67) Unclassified

Published in Nagoya Math. Jour., v. 12: 71-93, Dec. 1957.

A method using spectral sequences is applied to a study of the dimension of the tensor product $A \otimes_K \Gamma$ of two K -

algebras. Results are obtained when Γ is a ring of matrices, triangular matrices, polynomials or rational functions, so that in the first three cases $A \otimes_K \Gamma$ is,

respectively, the ring of matrices, triangular matrices or polynomials with coefficients in the arbitrary algebra A . Similar techniques yield additivity theorems for the dimensions associated with a tower of three algebras when one of the extensions is special. The domain of semi-primary rings is treated for the case when Γ is semi-simple.

COU.08:002

Columbia U. Dept. of Mechanical Engineering, New York.

THERMOELASTIC DISSIPATION DUE TO HIGH-SPEED DISLOCATIONS, by J. H. Weiner. Mar. 1, 1958 [11]p. incl. diagr. (Rept. no. CU-1-58AF52-ME) (AFOSR-TR-58-78) (AF 18(603)52) AD 158348 Unclassified

Also published in Jour. Appl. Phys., v. 29: 1305-1307, Sept. 1958.

The thermoelastic dissipation in an elastic solid due to an edge dislocation moving with rectilinear motion at an arbitrary speed is calculated analytically and numerical results presented. It is found that, at usual stress levels, this mechanism has only a minor effect in limiting dislocation speed.

COU.10:018

Columbia U. Electronics Research Labs., New York.

THEORY OF TIME-VARYING SAMPLED-DATA SYSTEMS, by B. Friedland. Apr. 15, 1957, 204p. incl. diagrs. tables, refs. (Technical rept. no. T-19/B; rept. no. CU-31-57AF677-EE) (AFOSR-TN-57-183) (AF 18(600)677) AD 126478 Unclassified

Some of the theoretical aspects of linear, time-varying sampled-data systems are discussed. Chapter II shows that components may be characterized by means of infinite, triangular transmission matrices, H , and signals by means of infinite signal vectors, x . Extensions of the Z-transform (generating function) method commonly used for fixed sampled-data systems are discussed in Chapter III. A particularly convenient method of dealing with periodically varying systems is presented in Chapter IV. The design of time-varying filters for the least squares filtering and prediction of sampled random data is discussed in Chapter V. Appendices summarizing some of the classical theory of difference equations and Z-transforms are included.

COU.10:019

Columbia U. Electronics Research Labs., New York.

DIGITAL CONTROLLERS IN FEEDBACK SYSTEMS, by J. R. Ragazzini. Mar. 15, 1957, 29p. incl. diagrs. table, refs. (Technical rept. no. T-18/B; rept. no. CU-30-57AF677-EE) (AFOSR-TN-57-205) (AF 18(600)677) AD 126502 Unclassified

Linear feedback control systems can be stabilized and compensated by means of digital controllers designed to implement a linear recursion formula. The constants in this recursion formula are chosen in such a manner as to produce a stable system whose stability is not dependent on a perfect knowledge of the system constants.

COU.10:020 - COU.10:023

This condition is achieved by including in the zeros of the overall pulse transfer function those zeros of the plant which have a magnitude equal to or greater than unity. Steady state response is controlled by causing the error sequence to tend toward zero in the steady state in response to test functions usually steps, ramps or constant accelerations. Finally, acceptable transient and ripple is achieved by applying design criteria which fulfill the specifications. Depending on which criterion is most important, minimum settling time, flexibility in response to a number of inputs or ripple-free operation, design techniques are available. Further flexibility in design can be attained by accepting digital controllers containing more than the minimum number of storage elements.

COU.10:020

Columbia U. [Electronics Research Labs.] New York.

GENERAL SYNTHESIS PROCEDURE FOR COMPUTER CONTROL OF SINGLE AND MULTI-LOOP LINEAR SYSTEMS, by R. E. Kalman and J. E. Bertram. Aug. 10, 1957, 1v, incl. diagrs. table, refs. (Technical rept. no. T-20/B; rept. no. CU-33-57AF677-EE) (AFOSR-TN-57-504) (AF 18(600)677) AD 136587 Unclassified

Also published in Trans. Amer. Inst. Elec. Engineers, v. 77 (Part II): 602-609, Jan. 1959.

This paper is concerned with the problem of designing optimal systems for the control of a plant governed by a linear differential equation with constant coefficients. Control is exerted by means of piecewise constant signals which can change only at the "sampling instants". Optimality means here, as in some nonlinear problems, that the system achieves equilibrium with zero steady-state error from any initial state as quickly as possible. The sequence of signals required for optimal control in the above sense is usually a linear combination of the state variables of the plant being controlled. In the simplest regulator problem when all state variables are accessible, the optimal system is realized by a very simple multi-feedback arrangement in which the only unconventional component is the sample-and-hold element. When some states are not accessible, when the plant includes time delays, or when dealing with a followup problem, the physical realization of optimal control requires real-time analog or digital computation. The requirements of machine computation for control purposes are derived here in a general way; the theory presented includes as special cases many commonly used methods for control system synthesis. (Contractor's abstract)

COU.10:021

Columbia U. [Electronics Research Labs.] New York.

ADDITIONAL TECHNIQUES FOR SAMPLED-DATA FEEDBACK PROBLEMS, by G. M. Kram. Aug. 15,

1957, 27p, incl. diagrs. refs. (Technical rept. no. T-21/B; rept. no. CU-35-57AF677-EE) (AFOSR-TN-57-592) (AF 18(600)677) AD 136578 Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 20-23, 1957.

Also published in I.R.E. WESCON Convention Record, Pt. 4: 157-165, 1957.

This paper extends the standard methods of Z-transforms to problems (a) which arise when sampling switches close for a duration time which is too long for the process to be adequately described by impulse modulation, and (b) which arise when the sampling switches operate at different sampling rates. In the case of the finite width sampling it is shown that the sampler can be approximated to any degree of accuracy by a set of paralleled, idealized switches followed by triangular holds. The problem of having samplers operating at different sampling rates is treated similarly. Each sampling switch is replaced by an equivalent system of switches in parallel, all switches operating at the same rate. Having replaced the original feedback systems by their equivalent models, Z-transform methods are then applied to obtain the transfer characteristics from which stability of these systems can be studied. (Contractor's abstract)

COU.10:022

Columbia U. [Electronics Research Labs.] New York.

AN EXTENSION OF THE SAMPLING THEOREM TO THE CASE WHERE THE FREQUENCY SPECTRUM OF THE TIME FUNCTION EXISTS IN A FINITE NUMBER OF DISCRETE BANDS, by P. Oden and J. Gilmm. Sept. 15, 1957, 16p, incl. diagrs. (Technical rept. no. T-22/B; rept. no. CU-36-57AF677-EE) (AFOSR-TN-57-716) (AF 18(600)677) AD 136709 Unclassified

It is shown that a function of time whose Fourier transform is non-zero only in a finite number of frequency bands can be exactly reconstructed from its value at a select number of sampling points which occur at an average frequency equal to the sum of the frequency bands along the positive and negative frequency axis. If the Fourier transform of the time function is symmetrical about the frequency origin, the sampling frequency is given by twice the sum of the band widths along the positive frequency axis.

COU.10:023

Columbia U. Electronics Research Lab., New York.

TIME-VARYING ANALYSIS OF A GUIDANCE SYSTEM, by B. Friedland. Oct. 15, 1957, 30p, incl. diagrs. table. (Technical rept. no. T-23/B; rept. no. CU-37-57AF677-EE) (AFOSR-TN-57-746) (AF 18(600)677) AD 136733 Unclassified

COU.10:024 - COU.10:027

Presented at meeting of the Amer. Inst. Elec. Engineers, New York, Feb. 2-7, 1958.

Also published in Trans. Amer. Inst. Elec. Engineers, v. 77(Part II): 75-81, May 1958.

The problem considered is that of steering a missile toward a target by means of a closed-loop control system. The control system has a device which obtains samples of the system error (the angle between the line of sight and the actual heading) at a uniform rate. These samples are shaped by a steering controller and passed into a zero order hold circuit. The output of this hold circuit is steering command of the missile. The rudder is assumed to respond without delay to the steering command. The computations indicate that the system may be expected to perform reasonably well without compensation if at least 4 sampling intervals are available during the interception period and if the loop gain is properly adjusted. A compensator which ensures that there will be no terminal error may be realized by using only fixed components and amplifiers with time-varying gain.

COU.10:024

Columbia U. [Electronics Research Lab.] New York.

THE EFFECT OF QUANTIZATION IN SAMPLED-FEED-BACK SYSTEMS, by J. E. Bertram. Nov. 15, 1957, 22p. incl. illus. (Technical rept. no. T-24/B; rept. no. CU-38-57AF677-EE) (AFOSR-TN-57-775) (AF 18(600)677) AD 148005 Unclassified

Presented at meeting of the Amer. Inst. Elec. Engineers, New York, Feb. 2-7, 1958.

Also published in Trans. Amer. Inst. Elec. Engineers, v. 77(Part II): 177-182, Sept. 1958.

When digital transducers are introduced into a sampled-data system, an error is produced which is a result of quantization. The error is bounded by replacing every quantizer with a unity gain element and an input which is equal in magnitude to the greatest error possible in the element. The magnitude of the output of the system resulting from all these inputs is an upper bound on the error. This bound is conservative because the signs of the error tend to alternate. The result provides a means for comparing various computing schemes and serves to select a value for the quantizing interval.

COU.10:025

Columbia U. [Electronics Research Labs.] New York.

A SYNTHESIS METHOD FOR MULTIPLE CONTROL SYSTEMS, by H. Freeman [1957] [4]p. incl. diagrs.

(AF 18(600)677)

Unclassified

Presented at Winter General meeting of the AIEE, New York, N. Y., Jan. 21-25, 1957.

Also published in Trans. Amer. Inst. Elec. Engineers, v. 76 (Part II): 28-31, Mar. 1957.

A method is developed for the systematic synthesis of multiple control systems which is based on the application of certain system constraints. These constraints reduce the degrees of freedom of the system without, however, resulting in an undue restriction on system performance. A system transfer matrix is described which characterizes the system. Through the application of the constraints it becomes possible to solve this matrix for the controller transfer functions required to achieve specified performance. This permits the synthesis of multiple control systems in a manner similar to that presently possible for single-input and single-output system. (Contractor's abstract)

COU.10:026

Columbia U. [Electronics Research Lab.] New York.

INPUT-OUTPUT ANALYSIS OF MULTIRATE FEED-BACK SYSTEMS, by G. M. Kranc. [1957] [8]p. incl. diagrs. (AF 18(600)677) Unclassified

Presented at Western Electronic Show and Convention, Los Angeles, Calif., Aug. 1956.

Published in I.R.E. Trans. of Professional Group on Automatic Control, v. PGAC-3: 21-28, Nov. 1957.

A general analytical technique described in this paper permits the extension of Z-transform methods to sampled-data systems containing synchronized switches which do not operate with the same sampling rate. Sampling periods of each switch are first expressed in the form $T/p_1 \dots T/p_n$ (where $p_1 \dots p_n$ are integers not equal to zero) and then it is shown that each switch with a period T/p can be replaced by a system of switches and advances and delay elements where each switch operates with a sampling period T . In this way, the original sampled-data system can be represented by an equivalent system containing switches operating with the same sampling rate. The general solution of such equivalent systems is outlined in this paper. (Contractor's abstract)

COU.10:027

Columbia U. Electronics Research Lab., New York.

LEAST SQUARES FILTERING AND PREDICTION OF NONSTATIONARY SAMPLED DATA, by B. Friedland. Dec. 15, 1957, 26p. incl. diagrs. refs. (Technical rept.

COU.10:028 - COU.10:031

no. T-25/B; rept. no. CU-39-57AF677-EE) (AFOSR-TN-58-24) (AF 18(600)677) AD 148063 Unclassified

Also published in Information and Control, v. 1: 297-313, Dec. 1958.

The design of a linear, least squares filter or predictor H for nonstationary sampled-data is shown to entail the inversion of an $n \times n$ matrix for the n^{th} row of the "transmission matrix," H which characterizes the device. By the use of an "ensemble-shaping" technique the computation required is reduced to tractable proportions. It is shown that even when the input data is stationary the filter which is optimum for all instants (and not only in the steady-state) is a time-varying device which approaches the optimum steady-state filter as the filterizing time becomes infinite.

COU.10:028

Columbia U. [Electronics Research Labs.] New York.

THE DESIGN OF ANALOG COMPUTER COMPENSATED CONTROL SYSTEMS, by S. C. Bigelow. Feb. 15, 1958, 30p. incl. diagrs. table, refs. (Technical rept. no. T-27/B; rept. no. CU-42-58AF677-EE) (AFOSR-TN-58-316) (AF 18(600)677) AD 154220 Unclassified

Also published in Trans. Amer. Inst. Elec. Engineers, v. 77 (Part II): 409-415, Nov. 1958.

A method is presented for solving the problem involved in designing a continuous feedback control system for the class of tandem-compensated duplicators. The method parallels that developed for sampled-data control systems (Trans. Amer. Inst. Electrical Engineers, v. 73, pt. 2, 1954; v. 75, pt. 2, 1956; Proc. Inst. Electrical Engineers, pt. 4, Monograph no. 43, July 15, 1952). An analog computer was used to realize the compensating system. Certain of the results of the procedure developed are general. The restrictions on the cancellation of poles and zeros of the plant by zeros and poles of the compensating system, and the explicit relations between steady-state system error or error constants and the coefficients of the over-all system transmission function hold, no matter what design procedure is used. (ASTIA abstract)

COU.10:029

Columbia U. [Electronics Research Labs.] New York.

THE EFFECTS OF QUANTIZATION IN FEEDBACK SYSTEMS, by J. E. Bertram. Mar. 15, 1958, 68p. incl. diagrs. refs. (Technical rept. no. T-28/B; rept. no. CU-44-56AF677-EE) (AFOSR-TN-58-323) (AF 18(600)-677) AD 154227; PB 137726 Unclassified

The linear sampled data system has been formulated in terms of the state variables of the system - a set of

numbers which completely summarizes the past history of the system. Using this formulation, the solution to any arbitrary input can be expressed by means of the fundamental matrix. The equations obtained permit an easy determination of the upper bound on the error in the state variables due to quantization. The same formulation has also proved useful in obtaining sufficient conditions for global stability for several classes of nonlinearities as well as the desirable operating conditions for a random quantizer.

COU.10:030

Columbia U. [Electronics Research Labs.] New York.

LINEAR MODULAR SEQUENTIAL CIRCUITS, by B. Friedland. Apr. 15, 1958, 20p. incl. diagrs. (Technical rept. no. T-29/B; rept. no. CU-45-58AF677-EE) (AFOSR-TN-58-555) (AF 18(600)677) AD 158373 Unclassified

Also published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-6: 61-68, Mar. 1959.

Sequential amplifier, unit delay, and modulo p summer circuits are considered in terms of a modular field description using vectors and matrices defined on this modular field. The sequential circuit is defined in terms of the vector equations relating the input $X(n)$, the output $Y(n)$, and the state of the circuit $S(n)$ at the time of the n th observation: (1) $Y(n) = F[S(n), X(n)]$ and (2) $S(n+1) = G[S(n), X(n)]$ where F and G represent arbitrary functions. Equality is interpreted as congruence, modulo p . It is shown that linear circuits, which are represented by linear equations, meet the additivity criterion of linear systems. The behavior of the circuit is described by trajectories in a space of k dimensions and p^k states. If the vector input is the null vector and the coefficients in the equation are constants, then the equation exhibits periodic trajectories of maximum period $p^k - 1$. Examples are provided to show that a linear sequential circuit may be treated by transform methods.

COU.10:031

Columbia U. [Electronics Research Labs.] New York.

CROSS-COUPLED MULTI-DIMENSIONAL FEEDBACK CONTROL SYSTEMS, by P. E. Sarachik. May 15, 1958, 119p. incl. diagrs. refs. (Technical rept. no. T-30/B; rept. no. CU-46-58AF677) (AFOSR-TN-58-556) (AF 18(600)677) AD 158374; PB 137446 Unclassified

Research was conducted on a study of cross-coupled multi-dimensional control systems. The following major aspects of the system are considered in this work. Mathematical description: The differential equations describing the system are derived and represented rather simply in vector matrix notation.

COU.10:032 - COU.10:035

Stability: The proper performance requirements of the over-all system are identified with the stability properties of a "reduced system." Three stability theorems are then proven, 2 of which are applicable to 2-dimensional systems and one to the n-dimensional case. **Dynamic behavior and synthesis:** The linearized equations in the vicinity of equilibrium are derived, and a synthesis procedure is suggested which combines the nonlinear methods required to establish stability in the large with linear designs for good dynamic behavior. (Contractor's abstract, modified)

In this way, a connection is established between some quantitative measure on one hand and the structure of the graph on the other. To this end, a new matrix in the theory of linear graphs has to be introduced and its properties studied. These properties are derived and given in terms of a number of theorems. They include (1) a relation between the path matrix and the vertex matrix, (2) the rank of the path matrix, and (3) the correspondence of the non-singular submatrices in the path matrix and the path cut sets. The probability of failure then is expressed in terms of the path matrix and is in fact given by the probability of the union of the "basis-cut-set products." (Contractor's abstract)

COU.10:032

Columbia U. [Electronics Research Labs.] New York.

TOPOLOGY AND THE SOLUTION OF LINEAR SYSTEMS, by R. B. Ash. June 15, 1958, 18p. incl. diagrs. table. (Technical rept. no. T-31/B; rept. no. CU-48-58AF677-EE) (AFOSR-TN-58-726) (AF 18(600)677) AD 162261
Unclassified

Also published in Jour. Franklin Inst., v. 268: 453-463, Dec. 1959.

The concepts of linear graph theory are applied to the study of feedback systems. Two topological matrices, called the exit and entrance matrices, are defined and the transmission matrix of the system is expressed in terms of these matrices. The properties of these matrices are examined, and a relation between non-singular submatrices and nontouching feedback loops is established. Graph theory and the theory of determinants allow a rigorous derivation of Mason's general gain formula. A systematic method, based on the topological formulas derived in the paper, of finding all forward paths and feedback loops without drawing the graph of the feedback system is demonstrated. (Contractor's abstract)

COU.10:034

Columbia U. [Electronics Research Labs.] New York.

ON PERIODICITY OF STATES IN LINEAR MODULAR SEQUENTIAL CIRCUITS, by B. Friedland. Sept. 15, 1958, 20p. incl. tables. (Technical rept. no. T-33/B; rept. no. CU-51-58AF677-EE) (AFOSR-TN-58-907) (AF 18(600)677) AD 204515
Unclassified

The state periodicity of unexcited, linear modular sequential circuits characterized by the vector-matrix equation $s(n+1) = A s(n)$ over $GF(p)$ is considered by application of Galois field theory. It is shown that if the minimal polynomial $m'(x)$ of A of degree k' is irreducible, the set of all matrix polynomials in A of degree k' form a Galois field isomorphic to $GF[p, m'(\lambda)]$, and consequently that the state period is equal to the period (order) of the subgroup generated by λ in $GF[p, m'(\lambda)]$. If the minimal polynomial is reducible, it is shown that the matrix period is the least common multiple of the periods generated by λ in $GF[p, m_i(\lambda)]$ where $m_i(x)$ are the irreducible factors of the characteristic polynomial of A , and that every state period is a divisor of the matrix period. (Contractor's abstract)

COU.10:033

Columbia U. [Electronics Research Labs.] New York.

RELIABILITY STUDY OF COMMUNICATION SYSTEMS, by O. Wing. Sept. 15, 1958, 23p. incl. diagrs. (Technical rept. no. T-32/B; rept. no. CU-50-58AF677-EE) (AFOSR-TN-58-890) (AF 18(600)677) AD 204139
Unclassified

This report presents a new method of analysis of the reliability of a communication system. The method makes use of the matrix method of the theory of linear graphs. The system under consideration consists of a number of communication stations connected by links. Associated with each link is a probability of failure. The problem is to express the probability of failure of the overall system in terms of some of the topological properties of the graph which represents the system.

COU.10:035

Columbia U. [Electronics Research Labs.] New York.

COMPLEX PLANE SCANNER, by C. M. Alala and P. Oden. Final rept. Jan. 15, 1958, 74p. incl. diagrs. refs. (Technical rept. no. T-26/B; rept. no. CU-41-58AF677-EE) (AFOSR-TN-58-29) (AF 18(600)677) AD 152220
Unclassified

A description of the circuits and the general theory of operation of a specialized type of analogue computer, the Complex Plane Scanner, are presented. Essentially, this computer will automatically map contours in the complex frequency plane into an arbitrary function plane. For example, Bode plots, Nichols charts, and modified Nyquist diagrams can easily be plotted. The Complex Plane Scanner is thus a useful tool in the design

COU.10:036; COU.13:004-006

and analysis of networks and feedback control systems. A brief resume of pertinent theory and applications of the computer is presented. (Contractor's abstract)

COU.10:036

Columbia U. [Electronics Research Lab.] New York.

STABILITY AND PHYSICAL REALIZABILITY CONSIDERATIONS IN THE SYNTHESIS OF MULTIPOLE CONTROL SYSTEMS, by H. Freeman. [1958] [5]p. incl. diagrs. refs. (AF 18(600)677) Unclassified

Presented at meeting of the Amer. Inst. Elec. Engineers, Montreal, Que. (Canada), June 24-28, 1957.

Published in Trans. Amer. Inst. Elec. Engineers, v. 77 (Part II): 1-5, Mar. 1958.

With the use of the canonical form for a multipole control system as the starting point, the characteristic equation of the system is derived and its roots related to the poles and zeros of the given plant. Conditions are established which must be imposed on the plant to permit the design of a stable system having an arbitrary response. This is followed by the development of a technique which, by imposing constraints on the over-all response, enables the system designer to achieve a stable design even when certain of the plant's poles and zeros lie in an unstable region of the complex frequency plane. The method permits the direct stability design of multipole control systems in a manner similar to that presently possible for the conventional 2-pole systems. It is applicable to continuous-data systems as well as to sampled-data systems. The conditions for the physical realizability of the controllers of a multipole control system designed for a specified over-all response are investigated, and it is shown that, except for the introduction of certain delays, physical realizability can always be achieved.

COU.13:004

Columbia U. Inst. of [Air] Flight Structures, New York.

ON VIBRATIONS OF CONICAL SHELLS, by G. Herrmann and I. Mirsky. Apr. 1957 [31]p. incl. diagrs. (Technical note no. 4; rept. no. CU-14-57AF1247-CE) (AFOSR-TN-57-181) (AF 18(600)1247) AD 126453 Unclassified

Frequencies of truncated conical shells are determined using a Rayleigh-Ritz procedure. Sinusoidal mode shapes are assumed, which satisfy the equation of motion of a corresponding cylindrical shell. The approximate values should therefore have good accuracy for small semi-vertical angles, or small "conicity." It was found that for short shells the conicity lowers the frequency somewhat, while for long shells the frequency increases appreciably with conicity. This influence is strongest if

the number of circumferential waves is 3. As may be expected, the frequency of thin shells and the lowest frequency are more sensitive to changes in shape. It is shown further that the equations of motion may be integrated in terms of known tabulated functions in several special cases. (Contractor's abstract)

COU.13:005

Columbia U. Inst. of [Air] Flight Structures, New York.

ON VIBRATIONS OF CYLINDRICAL SHELLS OF ELLIPTIC CROSS-SECTION, by G. Herrmann and I. Mirsky. Dec. 1957 [24]p. incl. illus. (Technical note no. 5; rept. no. CU-17-57AF1247-CE) (AFOSR-TN-57-734) (AF 18(600)1247) AD 136721; PB 138602 Unclassified

Frequencies of free vibration of thin elastic cylindrical shells of constant thickness and elliptic cross-section are determined for several modes of motion. It is shown that purely longitudinal motions, for small ellipticities, are governed by a Mathieu equation and that the square of the frequency of a slightly elliptic shell with semi-axes a and b is the arithmetic mean of the squares of the frequencies of 2 circular shells with radii a and b , respectively. Purely torsional motion appears to be unaffected by ellipticity, while purely transverse motion (breathing mode) does not exist in elliptic cylinders. Flexural motions are studied by energy methods. It is found that in the absence of nodal lines parallel to the generator, the ellipticity increases the frequency considerably for shells of like cross-sectional area. If cylindrical shells of like circumference, that is of like mass, are compared with one another, the influence of ellipticity is stronger. (Contractor's abstract)

COU.13:006

Columbia U. Inst. of [Air] Flight Structures, New York.

NONAXIALLY SYMMETRIC MOTIONS OF CYLINDRICAL SHELLS, by I. Mirsky and G. Herrmann. [1957] [8]p. incl. diagrs. [AFOSR-TN-58-112] (AF 18(600)1247) AD152020 Unclassified

Presented at meeting of the Acoust. Soc. Amer., New York, May 23-25, 1957.

Abstract published in Jour. Acoust. Soc. Amer., v. 29: 772, June 1957.

Also published in Jour. Acoust. Soc. Amer., v. 29: 1116-1123, Oct. 1957.

A Timoshenko-type theory of cylindrical shells, developed by the authors in a previous paper (G. Herrmann and I. Mirsky, Jour. Appl. Mech., v. 23: 563-568, Dec. 1956) for the case of axial symmetry, is generalized in the present paper to include nonaxially symmetric motions. As an

COU. 13:007; COU. 14:005-007

application the propagation of free harmonic waves in the axial direction of a shell of infinite extent is studied and discussed in the light of previous work on this problem. (Contractor's abstract)

COU.13:007

Columbia U. Inst. of [Air] Flight Structures, New York.

ON A COMPLEMENTARY ENERGY PRINCIPLE IN LINEAR THERMOELASTICITY, by G. Herrmann. [1956] [1]p. (AFOSR-TN-58-731) (AF 18(600)1247) AD 162266
Unclassified

Also published in Jour. Aero/Space Sciences, v. 25: 660, Oct. 1958.

A variational principle for linear thermoelasticity, corresponding to Castigliano's theorem of classical linear elasticity, is established. The proof of the principle is based on Biot's formulation of the equations of the thermoelasticity which include the effect of entropy displacement. The author's principle constitutes a counterpart of the variational principle established by Biot for the thermoelastic linear case. The author promises that a less restricted proof of the present principle will be given in the future and that a more general variational principle for thermoelasticity will be formulated to correspond to Reissner's variational principle for both stresses and displacements in classical elasticity.

COU.14:005

Columbia U. School of Engineering, New York.

THE TEMPERATURE DEPENDENCE OF FLOW AND FRACTURE IN COATED ZINC SINGLE CRYSTALS, by L. C. Weiner. July 16, 1957 [18]p. incl. diagrs. table, refs. (AFOSR-TN-57-385) (AF 18(600)898, Task I) AD 132460
Unclassified

Also published in Trans. Metall. Soc. AIME, v. 212: 253-256, Apr. 1958.

For zinc single crystals, $\chi_0 = 3^\circ$, a copper coating raises both the cleavage and yield strengths over a large temperature range. Two ductile to brittle transition temperatures are observed, one associated with slip after completion of twinning, the other, with twinning. Surface films have no effect on the higher transition temperature, while they lower the other. For crystals $\chi_0 = 83^\circ$, a

surface film decreases the cleavage strength, making it independent of temperature, and also raises the transition temperature. These observations and effects are described on the basis of a dislocation-pile-up-at-a-barrier model; in crystals $\chi_0 = 3^\circ$ the number and distribution of twins play a vital role.

COU.14:006

Columbia U. School of Engineering, New York.

EFFECTS OF GASEOUS AND LIQUID ENVIRONMENTS ON THE BRITTLE FRACTURE OF ZINC SINGLE CRYSTALS, by L. C. Weiner. Aug. 29, 1957 [7]p. incl. table refs. (AFOSR-TN-57-553) (AF 18(600)898, Task I) AD 136537
Unclassified

Also published in Trans. Metall. Soc. AIME, v. 212: 342-343, June 1958

The effects were studied of solid environments on the brittle fracture of Zn single crystals. Results are given of gaseous and liquid environments on cleavage strength. N, H, He, and CO₂ did not react with the Zn crystals to

produce a surface coating and did not effect σ_F , the normal fracture stress. HCl and H₂S reacted to form a uniform, adherent surface layer of ZnCl₂ and ZnS, respectively. The films were of sufficient thickness to cause an increase in σ_F of the same order of magnitude as that of initially coated specimens. An O atmosphere increased σ_F similar to that noted with coated crystals, but no coating was visible. However, specimens treated in an O atmosphere and subsequently etched in dilute HNO₃ gave a value of σ_{FM} (mean value) of 2475 psi.

A ZNO surface film of sufficient thickness was formed to cause this large increase in σ_F . A gaseous or

liquid environment will only increase the cleavage strength of initially clean Zn single crystals, when the medium reacts to form an adherent surface film of a thickness greater than a few hundred angstroms.

COU.14:007

Columbia U. School of Engineering, New York.

BENDING OF COATED ZINC CRYSTALS, by L. C. Weiner. Aug. 29, 1957, 3p. (AFOSR-TN-57-560) (AF 18(600)898, Task I) AD 136551
Unclassified

Also published in Acta Metallurgica, v. 6: 135-136, Feb. 1958.

In studying the effects of solid environments on the tensile brittle fracture of Zn single crystals, experiments were conducted to determine whether similar effects occur in bending. Both clean-surfaced and electrodeposited-Cu-coated (2000 to 4500 Å) specimens were used. The results failed to show any significant effect of a solid environment. For 21 clean crystals the mean value of S was 8900 ± 535 psi as compared with a mean value of 9200 ± 655 psi observed with 23 coated specimens. The orientation of the basal plane relative to the axis of loading was not important, since the test results indicated no difference between crystals, both clean and coated, tested

COU.14:008; COU.15:003; COU.17:005

with their basal planes either parallel or normal to the axis of loading. A 48% decrease in cleavage strength was observed in tension for crystals $\chi_0 = 83^\circ$ possessing a surface film. In bending, no effect due to a solid environment was found. The mean value of S for clean and coated crystals was observed to be 2000 ± 340 psi and 2250 ± 640 psi, respectively. In crystals oriented $\chi_0 = 3^\circ$, twinning was the predominant mode of plastic deformation in regions of tension, while for specimens of the other orientation, $\chi_0 = 83^\circ$, twinning occurred in regions of compression. The results indicated that tensile tests at appropriate testing temperatures rather than bend tests are necessary for a study of the brittle behavior of materials which exhibit twinning.

COU.14:008

Columbia U. [School of Engineering] New York.

INVESTIGATION OF THE ROLES OF ABSOLUTE GRAIN SIZE AND NUMBER OF GRAINS IN THE CROSS-SECTION AS FACTORS CONTROLLING FLOW AND FRACTURE STRESSES AT LOW TEMPERATURE, by J. W. Hill. Feb. 28, 1958, 18p. incl. diagrs. tables, (AFOSR-TN-58-882) (AF 18(600)898; Task I) AD 162215; PB 138107 Unclassified

An investigation was conducted to determine whether the absolute grain size or the number of grains in the cross-sectional area is the controlling factor in determining flow and fracture stress at low temperatures. As-rolled ferrites containing 0.03 C, 0.53 Mn, and 0.19 Si, were subjected to cold working and machined to contour specimens having diam at min cross section of about 0.045, 0.075, and 0.090 in. The specimens were mechanically polished, cleaned by re-centerdrilling and washing with benzene, and heat treated. Two to $3\frac{1}{2}$ hr were required at 700°C to produce ASTM grain sizes of about 6, 5, and 4. The specimens were immersed in either a single vacuum dewar of liquid nitrogen or double dewar containing liquid nitrogen in the outer dewar and liquid helium in the inner dewar. At these low temperatures, the specimens were pulled with an Instron tensile testing machine at a crosshead speed of 0.1 in. min. The upper yield, lower yield, and fracture loads were taken from the Instron recorder as the highest load before drop in load at yield, the lowest load occurring immediately after the drop in load at yield, and the load at which the specimen broke. A plot of the square of the stress vs the reciprocal of the average grain diam is a single straight-line relationship. All the low-temperature data for the reduction of area vs the reciprocal of the average grain diam also shows a straight-line relationship. These results indicate that the absolute grain size and not the number of grains in the cross section determines tensile properties at low temperatures.

COU.15:003

Columbia U. [School of Mines] New York.

THE DRIVING FORCE FOR RECRYSTALLIZATION IN BENT SINGLE CRYSTALS OF SILVER, by J. W. Semmel, Jr. and E. S. Machlin. [1957] [15]p. incl. illus. diagrs. tables, refs. [AF 18(600)899] Unclassified

Published in *Acta Metallurgica*, v. 5: 582-598, Oct. 1957.

During an experimental study of recrystallization of bent single crystals of silver, in which measurements of dislocation density were made, it was found that the energy associated with the dislocations comprised but a small fraction of the driving energy for recrystallization. Experimental evidence was obtained to support the theory that excess point defects produced by the bend deformation, in particular vacancies, provide the major source of the driving energy for recrystallization under the present experimental conditions. Two annealing stages were found during which the driving energy for recrystallization decreased to values below that necessary to achieve recrystallization on subsequent heating to high temperatures. This process is called "degradation." Specimens bent to 12% outer fiber strain or less degraded much more rapidly than specimens bent to 23% outer fiber strain. It is postulated that the vacancy-sinks are not infinite and that the longer degradation time is a measure of the time required for the excess vacancies to diffuse to the specimen surface. (Contractor's abstract)

COU.17:005

Columbia U. [School of Mines] New York.

GRAIN GROWTH IN DILUTE ALLOYS OF COPPER, by S. Weinig and E. S. Machlin. [1957] [3]p. incl. diagrs. table. [AF 18(600)965] Unclassified

Published in *Jour. Metals*, v. 9: 843-845, July 1957.

An experimental study of grain growth in dilute binary alloys of copper was performed. It was found that the growth law $D = Kt^n$ fit most of the data, the grain growth exponent n decreased with solute content until a saturation value was obtained at slightly under 0.2 for both silicon and aluminum solutes. It is concluded that the grain growth exponent n depends upon solute adsorption at the grain boundaries. An estimate of the activation energy was made and it was found that the activation energy decreased with temperature. The activation energies for grain boundary migration compare well with values obtained from internal friction studies on identical alloys. This contributes strong experimental support for the two-step mechanism for complete boundary stress relaxation. (Contractor's abstract)

COU.17:006, 007; CEX. 01:001;
CIP.01:001

COU.17:006

Columbia U. School of Mines, New York.

GRAIN BOUNDARY SLIDING IN COPPER BI-CRYSTALS
(Abstract), by J. Intrater and E. S. Machlin. [1957] [1]p.
[AF 18(600)965] UnclassifiedPresented at meeting of the Inst. of Metals Div.,
A.I.M.E., Chicago, Ill., Nov. 3-7, 1957.

Published in Jour. Metals, v. 9: 31, Oct. 1957.

The phenomenon of grain boundary sliding (motion of grains along a common boundary) was studied in bi-crystals of copper which were oriented to minimize slip in the adjoining grains. It was found that sliding occurred within a very narrow zone. Prior plastic deformation is not necessary to achieve boundary sliding; however, when specimens were plastically deformed prior to grain boundary sliding, a decrease in the flow resistance of the region adjoining the grain boundary to shear stress parallel to the boundary was observed. Sliding is spasmodic with no incubation time and occurs with an activation energy of 40,000 cal/mol when tested in a vacuum of 5×10^{-4} mm Hg and 20,000 cal/mol when tested in hydrogen. Cracks along the boundary are found on bi-crystals test in vacuum and isolated voids are found on testing in hydrogen. The number of voids is directly dependent upon the amount of grain boundary sliding and is independent of temperature. It is believed that during grain boundary sliding pure sliding occurs along the straight sections of the boundary between the boundary projections (jogs). High stresses are developed at these jogs, indicating local plastic deformation. After sufficient plastic deformation fracture occurs, producing voids.

and pure sliding were devised. Voids were produced along the bicrystal boundaries subjected to sliding at the elevated temperature. The number of voids produced depended monotonically upon the amount of grain boundary sliding solely. This number of voids per amount of grain boundary sliding was found to be independent of temperature, but strongly dependent upon the jogged character of the boundary. The study, demonstrated the predominance of the grain boundary sliding mechanism of creep rupture, and the unimportance of vacancy condensation. A beginning was achieved toward providing a basis for alloy design to withstand high temperature failure.

CEX.01:001

Combustion and Explosives Research, Inc., Pittsburgh, Pa.

EXCESS ENTHALPY AND THE INITIATION AND
STABILITY OF COMBUSTION WAVES, by G. von Elbe
and B. Lewis. [1958] 9p. incl. table. (AFOSR-TN-58-
349) (AF 49(638)307) AD 154254 Unclassified

Also published in Seventh Symposium (Internat'l.) on
Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-
Sept. 3, 1958), London, Butterworths Scientific Publica-
tions, 1958, p. 342-346.

A review is presented of the question of excess enthalpy
in combustion waves. No final conclusions are pre-
sented, but theoretical considerations and experimental
facts necessary for future studies on the ignition prob-
lem are examined.

CIP.01:001

Combustion Inst., Pittsburgh, Pa.

SIXTH SYMPOSIUM (INTERNATIONAL) ON COMBUS-
TION, Yale U., New Haven, Conn., (Aug. 19-24, 1956),
N. Y., Reinhold, 1957, 943p. incl. illus. diagrs. tables,
refs. (AFOSR-TR-57-76) (Sponsored jointly by Air
Force Office of Scientific Research under AF 18(603)73,
Office of Ordnance Research, and Office of Naval Re-
search) Unclassified

A collection of 129 papers are presented, which provide
information on the theoretical concepts and principles
of engineering applications for those working on the
many aspects of combustion — chemical, kinetic, aero-
dynamic, and thermodynamic. Subject coverage of the
papers includes structure and propagation of laminar
and turbulent flames, high speed reactions, flame
stabilization in fast streams, instability in combustion
chambers, ignition, combustion of explosives and solid
propellants, evaporation and combustion of droplets and
sprays, experimental and analytical techniques in com-
bustion, and applications of combustion. Resumes of
panel discussions are included on the topics of future
problems in combustion research, high speed reactions,

COU.17:007

Columbia U. School of Mines, New York.

GRAIN BOUNDARY STRESS RELAXATION AND
SLIDING; SOLUTES AND INTERACTIONS. [1958]
[16]p. incl. refs. (AFOSR-TR-58-123) (AF 18(606)965)
AD 202924; PB 139821 Unclassified

The mechanism of grain boundary stress relaxation was
investigated. The effects of dilute solute elements were
investigated to provide an experimental basis for in-
duction of potential mechanisms. Complete grain bound-
ary stress relaxation was deduced to result from 2 de-
pendent processes: (1) grain boundary migration con-
trolling in pure metals, and (2) grain boundary sliding
controlling in alloys. Testing of grain boundary sliding
in bicrystals was conducted. Two phenomena, zone
shear and pure sliding, produced relative motions of
grains tangential to their common boundary. The time
and temperature dependence, and the morphology of
pure sliding were measured. Theories for zone shear

CIP.01:002; CGT.01:001;
COP.01:001, 002

and flame stabilization in fast streams.

CIP.01:002

Combustion Inst., Pittsburgh, Pa.

SIXTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION: ABSTRACTS OF PAPERS, Yale U., New Haven, Conn., Aug. 19-24, 1956. [1957] 208p. incl. tables, refs. (AFOSR-TR-57-76a) [Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)73, Office of Ordnance Research, and Office of Naval Research] Unclassified

Committee on Math. Biology, Chicago, Ill. see
Chicago U. Committee on Math. Biology, Ill.

CGT.01:001

Compagnie Generale de Telegraphie Sans Fil (France).

RECOMBINATION LIGHT EMISSION IN GERMANIUM. Final technical rept. [1958] 12p. diagrs. (AFOSR-TR-58-38) (AF 61(514)1148) AD 154118 Unclassified

The basic experiment consisted of passing current forward through a rectifying junction and observing which photons were emitted from the outside of the semiconductor specimen. Experiments were also conducted on Si with a Benoit-Weierstrass sphere. Al wire alloy junctions on n-type Si were used as well as P-diffused junctions on a p-type sample. A modified Klipp symmetrical double monochromator and the Perkin-Elmer monochromator were used in the experiments. A system was developed for studying accurately how the energy emitted at a given wavelength depends on current through the junction. A typical recording of the emitted light with current density of a few hundred amp/cm² indicated the existence of 2 peaks in the emitted radiation, one of which was the band-to-band gap at a wavelength of about 1.74μ at 77°K. The second peak, centered at about 2.30μ, was observed only below about 200°K. The amount of trap radiation was found to be approximately linearly related to the dislocation density, as a result of experiments with Ge. Measurements were made of radiative efficiency by passing a signal through a spectrometer and measuring the peak intensity at 0.52 ev with approximately 50 ma through the junction. At 20°K, a weak peak 15.10⁻³ ev on the high-energy side of the band-to-band peak was observed on an Sb-doped Ge specimen. Measurements of recombination light in Si were initiated.

COP.01:001

Copenhagen U. Inst. of Neurophysiology (Denmark).

RESPONSES IN SINGLE OPTIC TRACT FIBERS OF

CAT TO MONOCHROMATIC LIGHT. CORRELATION WITH CONDUCTION VELOCITY, by M. A. Lennox. [1957] [2]p. [AF 61(514)1194] Unclassified

Presented at meeting of the Scandinavian Physiol. Soc., Stockholm (Sweden), Aug. 25, 1957.

Published in Acta Physiologica Scandinavica, v. 42: Suppl. 145, 1957.

In chloralose-urethane anesthetized cats, a just supra-maximal electrical stimulus was applied to one optic nerve just behind the intact eye and the response recorded with a gross and an immediately adjacent glass capillary microelectrode from the contralateral optic tract. Responses were then recorded in these same fibers by flashing the intact eye with light which could be varied independently with respect to intensity, color, duration, and frequency. The responses to light evoked in single optic tract fibers in the cat were of the three types, "on," "off," and "on-off," and the response type of any one fiber was a fixed characteristic. The majority of the optic tract fibers were off fibers, and these appeared to be the only units allowing discrimination of the brightness of light. The "on" responses differed according to the color of the light, and these differences were correlated with the conduction velocity along the fiber.

COP.01:002

Copenhagen U. Inst. of Neurophysiology (Denmark).

SINGLE FIBER RESPONSES TO ELECTRICAL STIMULATION IN CAT'S OPTIC TRACT, by M. A. Lennox. [1958] [8]p. incl. diagrs. tables, refs. (AFOSR-TN-58-430) (AF 61(514)1194) AD 158234 Unclassified

Also published in Jour. Neurophysiol., v. 21: 62-69, Jan. 1958.

The properties of the optic tract in the cat have been the cause of occasional disagreement. This experiment was performed to examine the evidence obtainable from single fiber responses to electrical stimulation of the contralateral optic nerve. Twenty-six animals were used (2- 2.5kg.) under deep chloralose-urethane anesthesia, and this report concerns 73 units obtained from 14 successful experiments. By means of KCl-filled glass microelectrodes with tip diameters of 0.15-0.4μ, unit responses were found. For comparison, the gross response was recorded with an immediately adjacent uni-polar or concentric electrode. In the axons, each stimulus above threshold evoked a single spike of constant amplitude and latency at all stimulus strengths. The single fiber response was always positive and usually monophasic; the amplitude varied between 0.5 and 10 mv. The duration of the rising phase tended to be correlated with latency and thus with conduction velocity and fiber size, being the shorter, the faster the conduction velocity. The refractory period was longer in fibers with slow

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than in those with rapid conduction velocity. Calculated for the mean measured distance between stimulating and recording electrodes (41 ± 1 mm), the three significant latency groups correspond to conduction velocities of about 52, 37, and 16 m/sec.

COP.01:003

Copenhagen U. [Inst. of Neurophysiology] (Denmark).

STUDY OF THE ORGANIZATION OF THE VISUAL SYSTEM IN RESPECT TO COLOR, by M. A. Lennox. Final technical rept. Jan. 1-Dec. 31, 1957 [10]p. incl. refs. (AFOSR-TR-56-24) (AF 61(514)1194) AD 152199

Unclassified

The correlation of conduction velocity with response to light, especially to the color of the light, of single units (optic tract fibers) was studied. The experimental animals were cats under chloralose-urethane anesthesia. The only correlate with the conduction velocity was the differential response of the units to the 2 colors, blue and red. Slow fibers were more responsive to blue and fast fibers to red. Responses after cessation of brief light flashes were more common than any other type of response. These occurred in 60% of the single units. Three types of responses were seen: those in which the number of spikes was determined sensitively by the quantity, those in which the number of spikes was only in general related to the quantity of light, and mixed types of response with both components. No correlation was noted between type of response and conduction velocity, nor did these units respond differently to blue and to red. An electroencephalographic and followup study of candidates for jet pilot training in 1953 to 1955 confirmed earlier findings of a correlation between marked or paroxysmally abnormal EEG's and service performance that the crash rate was 3 times as high in trainees with as in those without such abnormalities.

istic for any one unit. The on responses of on and of on-off units differed in general from each other with respect to latency, spike number, and frequency of the response to light, with respect to color sensitivity, and with respect to fiber size. The pure on fibers were less "active" in response to light, more apt to be blue sensitive, and tended to belong to the slower conduction velocity groups. By less "active" is meant that the latency of the response to light was longer, the number of spikes fewer, and the discharge frequency lower. The on-off fibers were more "active" in their response, they included the only two red sensitive units found, and they belonged preferentially in the fast conduction velocity groups. The only consistent correlation with conduction velocity was the differential response of the unit to the two colors, blue and red; fibers with low conduction velocities responded more actively to blue than to red, while those with high conduction velocities responded more actively to red. These findings contribute to the evidence that not only peripheral, but also central nervous mechanisms are involved in the reception of color.

COP.01:005

Copenhagen U. Inst. of Neurophysiology (Denmark).

CENTRAL NERVOUS MECHANISMS IN COLOR VISION, by M. A. Lennox. Jan. 27, 1958, 8p. incl. diagrs. (Sponsored jointly by the Danish State Research Foundation and Air Force Office of Scientific Research under AF 61-(514)1194) AD 202485

Unclassified

Presented at meeting of the Danish Neurological Soc., Jan. 27, 1958.

In this neurophysiological study using cats, an attempt was made to discover what happens in the brain when the color of a light (stimulus) is changed. Recordings were made of the response from the cortex when the cat's eye was flashed with blue, green, yellow, and red light. At high intensities, the response occurred earlier when the light was red, later when it was yellow, and latest when it was blue or green. Tests verified that the photochemical reaction took place fastest in the eye when the light was red and that the red-sensitive receptors were connected with large fibers which conducted the impulse faster in the central nervous system than in the case of the other light stimuli. For a response of a given size, the arrival time is 5 msec earlier when the light is red or yellow than when it is blue or green. It is concluded that the arrival time of an impulse offers a possibility to the brain to judge the quality (color) of the stimulus. In addition, it is pointed out that the eye is always making small scanning motions, and that without these motions, color cannot be seen. Thus, this scanning motion may provide the brain a means of comparing latencies.

COP.01:004

Copenhagen U. Inst. of Neurophysiology (Denmark).

THE ON RESPONSES TO COLORED FLASH IN SINGLE OPTIC TRACT FIBERS OF CAT. CORRELATION WITH CONDUCTION VELOCITY, by M. A. Lennox. Apr. 1957 [37]p. incl. diagrs. tables, refs. (AFOSR-TR-56-24a) (Sponsored jointly by Danish State Research Foundation and Air Force Office of Scientific Research under AF 61-(514)1194) AD 202485

Unclassified

Also published in Jour. Neurophysiol., v. 21: 70-84, Jan. 1958.

Eighteen on responses of on (11) or on-off (7) units to various intensities and durations of red, blue, and white light were obtained. In 13 of these units, responses to optic nerve stimulation were also obtained. The type of response of each fiber was found to be a fixed character-

CRK.01:001 - CRK.01:004

CRK.01:001

Cork U. Coll. (Ireland).

THE HYPERCIRCLE METHOD APPLIED TO THE SOLUTION OF THE BIHARMONIC EQUATION. I, by V. G. Hart. Dec. 1957, 62p. incl. diagrs. (AFOSR-TN-58-172) (AF 61(514)1163) AD 152203 Unclassified

The hypercircle technique utilizes a function-space representation in which the point of intersection of two orthogonal linear subspaces corresponds to the solution (which we suppose unique) of a boundary-value problem. General points on the two subspaces correspond to solutions of the original problem with some conditions relaxed and may be easily found. A point is selected on each subspace, and an attempt is made to draw each point close to the point of intersection by means of a least square procedure. Then provided that the metric of function-space is positive-definite (which will always be the case in the subsequent work), the point of intersection of the subspaces is located on a geometrical figure called a hypercircle. When the hypercircle has been found, the method provides upper and lower bounds on a certain functional involving the solution of the problem under consideration. Also it is possible to estimate the mean-square error involved at all stages of the process, this quantity being represented by the square of the radius of the hypercircle. In this work pointwise bounds on the solution of a boundary-value problem are not obtained, but methods are available for such a process if desired. (Contractor's abstract)

CRK.01:002

Cork U. Coll. (Ireland).

MULTI-RING PLATES, A STEP FUNCTION APPROACH, by P. M. Quinlan. Jan. 1958, 26p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-58-211) (AF 61(514)1163) AD 154112; PB 134277 Unclassified

By introducing suitable functions a single, discontinuous, differential equation is written for the symmetrical bending of an elastic plate consisting of a number of concentric discs, each of constant thickness. The concentrated uniform ring load is taken as the fundamental load type, from which all other loading can be derived by integration. The case of a concentrated ring torque is obtained by applying an appropriate limiting technique to the ring load. The case of a disc of variable thickness is obtained by letting the number of discs in the plate become infinite, thereby making the solution of the problem depend on obtaining a particular integral of a second order differential equation with variable coefficients. Solutions are given for a hollow disc, where the thickness varies as some power (not necessarily an integer) of the radius. Finally, a theory of the bending of prestressed concrete circular slabs is developed, in which the solution involves concentrated ring loads and torques both of

which have been obtained in the present paper. (Contractor's abstract)

CRK.01:003

Cork U. Coll. (Ireland).

RECTANGULAR PLATES. A NEW APPROACH, by P. M. Quinlan. Jan. 1958 [47]p. incl. diagrs. (Technical note no. 3) (AFOSR-TN-58-259) (AF 61(514)1163) AD 154163; PB 134511 Unclassified

A Fourier double sine series expansion is obtained for the deflection in a simply supported rectangular plate. This is done by introducing a delta function into the plate equation for a concentrated load, then adding the series to produce a singly infinite series. Solutions are obtained for plates fixed horizontally along a pair of opposite edges by means of suitable complementary functions. Formulas are established for transverse bending moments, and suitable asymptotic series are introduced to improve the convergence of the series involved. The case of a concentrated torque is obtained by applying an appropriate limiting technique to the concentrated load case. Influence diagrams are given for transverse moment at the center of a simply supported rectangular plate with $b = 2a$, for both concentrated loads and torques. This is repeated for the same rectangular plate when fixed along two opposite edges. The solution to the case of a loaded semi-infinite strip is obtained by taking the limit of the previous solutions as b/a tends to infinity. The case where the strip is fixed horizontally along all finite edges is shown to lead to a singly infinite set of simultaneous equations, and is presented as the limiting case of the finite rectangle fixed along all edges. Solution to the problem of the loaded infinite strip follows in a similar manner. Finally, a complete theory of the bending of rectangular prestressed bridge slabs is developed. (Contractor's abstract)

CRK.01:004

Cork U. Coll. (Ireland).

TORSION OF SEMI-ELLIPTIC AND HOLLOW-ELLIPTIC SECTIONS, by P. M. Quinlan. July 1958, 23p. incl. diagrs. tables. (Technical note no. 4) (AFOSR-TN-58-283) (AF 61(514)1163) AD 203905; PB 136739 Unclassified

Conformal mapping is used to reduce the torsion problem for hollow-elliptic and semi-elliptic sections to a potential problem in a rectangle. In each case both the appropriate stress function and the torsional rigidity are obtained in series form, and the appropriate asymptotic form of the series for the stress components is given for use where greater precision is required. Solutions developed for the hollow elliptic tube and the prolate semi-elliptic shaft check with existing solutions

CRK.02:001-003; COA.03:001, 002

obtained by other methods. Solutions are also given when the above sections are cracked; the crack in each case being along the major axis extending respectively through the thickness of the tube, and to the focus of the shaft. The torsion of an oblate semi-elliptic shaft is also included. Calculations were performed to evaluate the effects of cracking on the sections, and the results are presented in tabular form. (Contractor's abstract)

CRK.02:001

Cork U. Coll. (Ireland).

ON THE COEFFICIENTS IN CERTAIN FOURIER SERIES, by P. B. Kennedy. [1958] 24p. (Technical note no. 1) (AFOSR-TN-58-171) (AF 61(514)1399) AD 152198 Unclassified

Also published in Jour. London Math. Soc., v. 33: 196-207, Apr. 1958.

The following problem is considered. A function satisfies a Lipschitz condition, in the strong sense, in a set of positive measure. Also the Fourier series of the function is subject to a gap hypothesis. What conclusion can be drawn regarding the order of magnitude of the Fourier coefficients of the function in question? The results obtained are roughly best-possible, and shed some light on a conjecture advanced by M. E. Noble in 1954 [Math. Annalen, v. 128: 55-62, 1954]. Remarks are made concerning the possibility of working with a weak Lipschitz condition; it is shown that the results do not extend to this case, even in a somewhat modified form. As an incidental result, it is pointed out that a function may satisfy a strong Lipschitz condition in a set of positive measure without satisfying such a condition in any interval. (Contractor's abstract)

CRK.02:002

Cork U. Coll. (Ireland).

REMARKS ON CONTINUITY CONDITIONS, by P. B. Kennedy. [1959] 8p. (Technical note no. 2) (AFOSR-TN-58-586) (AF 61(514)1399) AD 162107; PB 138974 Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 203-204, Apr. 1959.

A simple method is elaborated for Lipschitz conditions in intervals and sets of positive measure. Let E be any subset whatever of $(0,1)$. Let $\omega(k)$ be positive and monotonic increasing in $(0,1)$ and satisfy $\omega(k) \rightarrow 0$ as $k \rightarrow 0$. Then there exists a function $f(x)$ defined in $(0,1)$ such that (1) $\omega(k)$ is a modulus of continuity of $f(x)$ in E and (2) $f(x)$ is discontinuous at every interior point of the complement of E . (See item no. CRK.02:001)

CRK.02:003

Cork U. Coll. (Ireland).

THE DIVERGENCE OF TRIGONOMETRIC SERIES, by P. B. Kennedy and S. O'Shea. [1958] 13p. (Technical note no. 3) (AFOSR-TN-58-634) (AF 61(514)1399) AD 162164; PB 138975 Unclassified

A method due to Steinhaus, for the construction of everywhere-divergent trigonometric series with coefficients tending to zero, is generalized in a simple way. The generalization leads to some information concerning a theorem due to Zygmund, on the power of the set of points of convergence of certain trigonometric series with gaps. (Contractor's abstract)

COA.03:001

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE USE OF A SINGLE-PULSE SHOCK TUBE FOR THE STUDY OF HIGH-SPEED CHEMICAL KINETICS, by H. S. Glick, J. J. Klein, and W. Squire. [1956] 5p. (AF 18-(600)1332) Unclassified

A new shock tube technique for studying high-speed chemical kinetics has been developed at the Cornell Aeronautical Lab. With this technique, a reactive gas sample can be processed through a single high temperature pulse, which has amplitudes up to 10,000°K, durations from 0.1 to 10.0 msec, and cooling rates on the order of 10^6 °K/sec. The gas sample can be withdrawn from the shock tube after the experiment and the "debris" formed by the high temperature pulse can be analyzed by the most convenient means. The single-pulse shock tube has been used to study the kinetics of the formation of nitric oxide from air between 2000° and 3000°K. The reaction rates, activation energy, and mechanism of the nitric oxide reaction have been determined. (Contractor's abstract)

COA.03:002

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SINGLE-PULSE SHOCK TUBE STUDIES OF THE KINETICS OF THE REACTION $N_2 + O_2 = 2 NO$ BETWEEN 2000-3000°K, by H. S. Glick, J. J. Klein, and W. Squire. Sept. 1957 [26]p. incl. diagrs. refs. (Rept. no. AD-959-A-1) (AFOSR-TN-57-407) (AF 18(600)1332) AD 132485 Unclassified

Also published in Jour. Chem. Phys., v. 27: 850-857, Oct. 1957.

The single temperature pulse technique, developed at the Cornell Aeronautical Lab. has been used to study the

COA.03:003, 004; COA.01:005

kinetics of the formation of nitric oxide in the temperature range from 2000° to 3000°K. It has been found that the kinetics of the reaction are consistent with the chain mechanism proposed by Zeldovich. The rate-determining step in the chain is $O + N_2 \rightarrow NO + N$, with $\Delta H_{2500^\circ} =$

75.8 kcal/mole. The activation energy for this step is found to be 74 ± 5 kcal/mole. The collision cross-section, as calculated from classical reaction rate theory, is 10^{-16} cm^2 , which corresponds to a steric factor of about 0.05, assuming $\sigma_{N_2O} = 5 \text{ \AA}$. (Contractor's abstract)

COA.03:003

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SHOCK TUBE STUDY OF DISSOCIATION RELAXATION IN OXYGEN, by H. S. Glick and W. H. Wurster. [1957] [3]p. incl. illus. diagr. (AF 18(600)1332) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 47, Jan. 30, 1957.

Published in Jour. Chem. Phys., v. 27, 1224-1226, Nov. 1957.

A schlieren optical system and a high purity level shock tube have been used to study relaxation phenomena in oxygen at temperatures from 1200°K to 4000°K. Vibration and dissociation relaxation zones have been observed, and the data has been correlated with other experiments and existing theory. The measured vibrational relaxation times are in reasonable agreement with those measured by Blackman up to 3000°K. At higher temperatures, another non-equilibrium zone appears which is believed to be due to dissociation relaxation. The dissociation relaxation times, however, are several orders of magnitude shorter than those predicted by the theory of Bethe and Teller. The short dissociation relaxation times observed in the present experiments are corroborated by chemical kinetics studies of the formation of nitric oxide, and it is therefore believed that the theoretical model of dissociation kinetics for oxygen required refinement. Theoretical studies, based on the work of Rice, are being carried out in an effort to reconcile theory and experiment. (Contractor's abstract)

COA.03:004

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

RESEARCH IN RATE OF HIGH-SPEED REACTIONS, by W. H. Wurster. Final summary rept. Oct. 1954-Nov. 1957. Jan. 1958 [19]p. incl. illus. diagrs. refs. (Rept. no. AD-959-A-2) (AFOSR-TR-58-8) (AF 18-

(600)1332) AD 148054

Unclassified

The principles of a single temperature pulse shock tube which was developed for the study of high-speed chemical reactions are discussed. The shock tube enables a reactant gas to be processed by a predetermined temperature pulse of variable amplitude and duration; both the reaction rates and activation energies are determined by analyzing the resulting data. The kinetics of the $N_2 + O_2 \rightleftharpoons 2 NO$ reaction were investigated

between 2000° and 3000°K and were proven to be consistent with the chain mechanism proposed by Zeldovich (Acta Physicochimica U.R.S.S., v. 21: 577, 1946). An activation energy of 74 ± 5 kcal/mol was measured. Measurements of the relaxation time for O dissociation between 2000° and 4000°K yielded values which confirmed the validity of the chain mechanism for the NO reaction. The complementary use of high-speed spectrographic techniques in reaction studies is discussed.

COA.01:005

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE SHOCK TUNNEL AND ITS APPLICATIONS TO HYPERSONIC FLIGHT, by A. Hertzberg. June 1957 [45]p. incl. illus. diagrs. refs. (Rept. no. AD-1052-A-5; AGARD rept. no. 144) (AFOSR-TN-57-268) (AF 18(603)-10) AD 126567 Unclassified

Presented at Eleventh meeting of the AGARD Wind Tunnel and Model Testing Panel, Scheveningen (Netherlands), July 8-12, 1957.

This paper discusses the application of the shock tube to the study of the problems of hypersonic flight. The development of the shock tube into a short-duration wind tunnel for the study of supersonic air flow is reviewed historically. Modifications of the conventional shock tube which extend the shock tube into a tool for the study of hypersonic flows are described. The problems of operation and technique which these modified shock tubes introduce are discussed. The techniques of instrumentation for the brief flow durations of hypersonic shock tunnels are outlined. In particular, a technique is described for accurately measuring heat transfer within the short testing times available in shock tunnels. The results of preliminary experiments carried out to explore the effects of shock attenuation on the operation of shock tunnels are presented. Since the attenuation becomes so severe at high shock Mach numbers, shock tubes of more sophisticated design are being studied which promise to increase the testing time per unit length of shock tube up to twenty-five times that of the existing shock tubes, and hence alleviate the attenuation problem. A new technique for generating strong shock waves required for shock tunnel operation is described. (Contractor's abstract)

COA. 01:006-009; COA. 02:002

COA.01:006

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SHOCK TUBE DRIVER TECHNIQUES AND ATTENUATION MEASUREMENTS, by C. E. Witliff and M. R. Wilson. Aug. 1957, 34p. incl. diagrs. refs. (Rept. no. AD-1052-A-4) (AFOSR-TN-57-546) (AF 18(603)10) AD 136531
Unclassified

The development of the hypersonic shock tunnel at the Cornell Aeronautical Lab., Inc. has been accompanied by a study of various techniques for producing strong shock waves to drive the shock tunnel. The results of this study are described as to technique and relative efficiency of different driver gases, and the resultant attenuation of the shock wave in the low pressure tube. It has been found that as the strength of the shock wave increases so does the amount of attenuation. Furthermore, the more efficient a given driver technique is in producing a shock wave, the larger the degree of attenuation that is observed. A survey of the presently available theories on shock wave attenuation indicates that the theories do not accurately predict the attenuation of shock waves having Mach numbers greater than 2, whereas all of the experimental data reported herein are for shock wave Mach numbers greater than 4. This serves to illustrate the need for a better understanding of the attenuation of strong shock waves. (Contractor's abstract)

COA.01:007

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

A METHOD FOR IMPROVING THE PERFORMANCE OF SHOCK TUBES, by A. Russo and A. Hertzberg. Apr. 1957 [11]p. incl. diagrs. (AF 18(603)10)
Unclassified

Also published in *Jet Propulsion*, v. 27: 1191-1193, Nov. 1957.

Modifications of the basic shock tube are considered in order to improve the performance of shock tubes and, in particular, to extend the use of hydrogen to the generation of strong shock waves in air. These modifications are the double-diaphragm shock tube with monatomic buffer gases and the shock tube with an area change at the diaphragm station. The results of this investigation indicate that the use of a shock tube with an area discontinuity and the proper monatomic buffer gas should permit the generation of strong shock waves, using cold hydrogen as a driver gas, with over-all pressure ratios comparable to those required for existing combustion drivers. In addition, by using a buffer gas with the proper atomic weight, it is possible to control the downstream diaphragm pressure ratio to minimize the mass of the downstream diaphragm. (Contractor's abstract)

COA.01:008

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SIMILITUDE OF HYPERSONIC FLOWS OVER THIN AND SLENDER BODIES - AN EXTENSION TO REAL GASES, by H. K. Cheng. Feb. 1958 [19]p. incl. diagrs. refs. (Rept. no. AD-1052-A-6) (AFOSR-TN-58-87) (AF 18(603)10) AD 148136
Unclassified

On the basis of the governing equations and boundary conditions, similitude in the hypersonic inviscid flow fields over thin or slender bodies is examined, wherein the restriction to ideal gas with constant specific heats is removed. When local thermal (vibrational and chemical, etc.) equilibrium prevails, i.e., when the properties of gas are determined nearly by the thermodynamic properties corresponding to the local pressure and temperature (or density), the parameter $M_\infty \tau$ of Tsien and Hayes remains the controlling parameter for the similar fields of hypersonic flows past thin or slender bodies. However, general correlation of similar flows of real gases are possible only between flows under the same free-stream atmosphere, i.e., with the same p_∞ , ρ_∞ (or T_∞) and initial gas composition, say $(X_i)_\infty$'s. Examples of correlation are given for flows of real gases over wedges. (Contractor's abstract)

COA.01:009

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

MODIFICATIONS OF THE BASIC SHOCK TUBE TO IMPROVE ITS PERFORMANCE, by A. Russo and A. Hertzberg. Aug. 1958, 43p. incl. diagrs. tables, refs. (Rept. no. AD-1052-A-7) (AFOSR-TN-58-716) (AF 18(603)10) AD 162251
Unclassified

Basic modifications are considered which would improve the performance of shock tubes in producing higher shock strengths and extend the use of hydrogen in generating strong shock waves in air. These modifications are the double-diaphragm driver with monatomic buffer gases and an area contraction at the diaphragm station. The results of this investigation indicate that the use of a shock tube with an area contraction and the proper monatomic buffer gas will permit the generation of strong shock waves, using cold hydrogen as a driver gas, with overall pressure ratios comparable to those required for combustion drivers. It is also shown that, by using a buffer gas with the proper atomic weight, the downstream diaphragm pressure ratio may be controlled to minimize the mass of the downstream diaphragm. (Contractor's abstract)

COA.02:002

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

ACOUSTIC PROPAGATION IN A DIATOMIC GAS

COA. 02:003; COA. 04:001;
COA. 05:001, 002

SUBJECT TO THERMAL OR CHEMICAL RELAXATION, by W. E. Gibson and F. K. Moore. Dec. 1958 [61]p. incl. diagrs. refs. (Rept. no. HF-1056-A-2) (AFOSR-TN-58-1057) (AF 18(603)19) AD 206988 Unclassified

A theory of acoustic propagation in a gas subject to relaxation phenomena is presented. An acoustic equation is obtained for small disturbances from an equilibrium state of rest; this equation applies equally well to unsteady 1-dimensional waves or to steady 2-dimensional disturbances. The problem of a 2-dimensional airfoil in a supersonic flow of relaxing gas is considered. From the acoustic equation, the law of decay of shock waves and the values of the flow properties on the surface of the airfoil are derived. The asymptotic behavior of the flow field is obtained far from the airfoil so that the formation of an equilibrium wave is described. The acoustic equation involves the 2 wave operators which can be defined on the basis of the frozen and equilibrium sound speeds. The closeness of the sound speeds allows a simplification of the full equation to a variant of the telegraph equation. This approximate equation is uniquely determined by the requirements that the shock decay law and the exact value of the equilibrium sound speed be preserved. An explicit solution for the flow field is presented and proved to be in close agreement with the exact solution on the surface of the airfoil and in the asymptotic range. (Contractor's abstract)

COA.02:003

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

STUDIES OF A PROTOTYPE WAVE SUPERHEATER FACILITY FOR HYPERSONIC RESEARCH, by W. E. Smith and K. C. Weatherston. Dec. 1958, 115p. incl. illus. diagrs. table, refs. (Rept. no. HF-1056-A-1) (AFOSR-TR-58-158) (AF 18(603)19) AD 207244 Unclassified

Research was concerned with the development of a wave superheater which produces a continuous supersonic flow of air or other gases at temperatures and pressures needed for realistic hypersonic testing in the laboratory. A prototype, designed to generate 3000°R in air and 5500°R in argon, starting from room temperature, was built and successfully demonstrated the principles of wave superheater operation. The unique flow conditions, characterized by homogeneity, purity, and high temperature, pressure, and velocity, that are generated in hypersonic shock tubes and shock tunnels for short periods can be sustained for many seconds in a wave superheater. Many shock tubes are mounted on a rotating drum and fired cyclically in a manner to produce an uninterrupted jet of uncontaminated, superheated gas that is collected and expanded through a nozzle and test section. The test flow, being at typical shock tunnel conditions, reproduces the aerophysical phenomena, especially the high heat fluxes, associated with launching, gliding and re-entering hypersonic vehicles. The wave superheater is adaptable to full-scale

materials and structures testing, to high-speed aerodynamic research, and to studies of such basic processes as molecular dissociation and recombination as well as the interaction of electromagnetic radiation with ionized flow. A helium driven, preheated wave superheater was designed to superheat 4.3 lb of uncontaminated air/sec to 9000°R, or 12 lb of argon/sec to 17,000°R.

COA.04:001

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

BOUNDARY-LAYER TRANSITION AND HEAT TRANSFER IN SHOCK TUBES, by R. Hartunian, A. Russo, and P. Marrone. [1958] 6p. illus. diagrs. tables, refs. (AF 18(603)141) Unclassified

Also published in Proc. Heat Transfer and Fluid Mech. Inst., California U., Berkeley (June 19-21, 1958) Stanford, Stanford U. Press, 1958, p. 114-125.

An experimental study was made of the wall boundary layer in a shock tube operated over a wide range of shock Mach numbers and pressure levels, including those for which dissociation effects exist. Transition points were determined, and correlated in terms of boundary layer thickness. High cooling rates had a stabilizing effect on the laminar boundary layer. Laminar and turbulent flow heat transfer rates to the walls of the shock tubes were determined experimentally. The results of the heat transfer measurements substantiate existing theories in both laminar and turbulent flow regimes. (Contractor's abstract)

COA.05:001

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

TRANSITION PROBABILITIES FOR O₂ RADIATION IN THE NEAR ULTRAVIOLET, by W. H. Wurster and C. E. Treanor. Aug. 1958 [18]p. incl. illus. diagrs. (Rept. no. QM-1209-A-1) (AFOSR-TN-58-616) (AF 49(638)269) AD 162145 Unclassified

Spectroscopic shock tube experiments are described, showing the dominant role of the Schumann-Runge band system of oxygen in determining the ultraviolet absorptive properties of high-temperature air (2500 - 4500°K). The absorption by pure oxygen in this temperature range has been investigated at high resolution, and measured oscillator strengths for the (0, 13) and (0, 14) bands are presented. (Contractor's abstract)

COA.05:002

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

MEASUREMENTS OF FLOW PROPERTIES IN A

COR.01:013-015; COR.14:001

DISSOCIATED GAS (Abstract), by C. E. Treanor, T. C. Golian, and A. Hertzberg. [1958] [1]p. [AF 49(838)289]
Unclassified

Presented at meeting of the Fluid Dynamics Div. of the Amer. Phys. Soc., Lehigh U., Bethlehem, Pa., Nov. 25-27, 1957, v. 3: 289, June 19, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 289, June 19, 1958.

Direct measurements of the speed of sound have been performed in dissociated gases. The sound wave is produced by an abrupt expansion in the shock tube, and the velocity of the expanding cylindrical wave is determined from a schlieren photograph taken a known time later. A comparison of these results with calculated values of the speed of sound indicates that waves produced in this manner propagate as though vibration and dissociation do not participate.

COR.01:013

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

ELECTROANALYTICAL METHODS IN TRACE ANALYSIS, by W. D. Cooke. Feb. 1957 [35]p. incl. diagrs. refs. (Technical rept. no. 10) (AFOSR-TN-57-90) (AF 18(800)486) AD 120438
Unclassified

Published in Physical Methods in Chemical Analysis, v. III: 71-105, 1956.

In recent years scientists in widely different fields of endeavor are becoming increasingly aware of the important role of minor constituents in various phenomena. Extremely small quantities of material, sometimes as low as $10^{-6}\%$, can exert profound chemical and catalytic influences. The effect of microgram quantities of vitamins and hormones has been known for a long time. Traces of various metals are also of great importance in biological systems as well as in various aspects of technology. A review is presented of electroanalytical methods in trace analysis. Topics discussed are: (1) separation of minor constituents; (2) polarography; (3) amperometric procedures; (4) titration methods; and (5) anodic stripping of deposited metals. Sixty domestic and foreign references are included covering a time period from 1932 to 1956.

COR.01:014

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

POLAROGRAPHIC DETERMINATION OF SUBMICROGRAM QUANTITIES OF MOLYBDENUM, by W. D. Cooke. May 23, 1958, 15p. incl. table. (Technical note no. 11) (AFOSR-TN-58-468) (AF 18(800)488)
AD 158278
Unclassified

An analytical method which was capable of determining submicrogram quantities of molybdenum in highly purified salts was needed. A highly sensitive method employing catalytic reduction wave for molybdate had been reported. A comparison of the various procedures is undertaken here in order to find which method would have the widest applicability to the problems at hand. Two different supporting electrolytes, nitric acid and perchloric acid were found to give a catalytic effect in the polarographic reduction of molybdate. The effect of foreign electrolytes on the height of the polarographic waves is briefly touched upon. A summary of the results obtained in those cases where difficulties were experienced which were caused by large quantities of interfering elements is presented. The proposed methods were checked on synthetic samples or by standard additions of molybdenum and an accuracy of 5% was considered to be acceptable.

COR.01:015

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

DEVELOPMENT OF ELECTROCHEMICAL METHODS OF SEPARATION AND ANALYSIS FOR MILLIMICROGRAM AMOUNTS OF TRACE METALS, by W. D. Cooke. Final technical rept. June 17, 1958, 10p. incl. refs. (AFOSR-TN-58-528) (AF 18(600)486)
AD 158342
Unclassified

A summary is given on the development of methods which would increase the sensitivity of electrochemical methods of analysis. A bibliography of the technical notes and journal publications which give the details of the work is given.

COR.14:001

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

GASEOUS SPECIES IN THE VAPORIZATION OF POTASSIUM HYDROXIDE, by R. F. Porter and R. C. Schoonmaker. [1957] [4]p. incl. diagrs. table, refs. (AFOSR-TN-57-633) (AF 18(603)1) AD 136619
Unclassified

Also published in Jour. Phys. Chem., v. 62: 234-237, Feb. 1958.

COR.14:002 - COR.14:005

A mass spectrometric study of the gaseous species produced in the vaporization of potassium hydroxide shows that in the temperature range 300 to 450° KOH vaporizes mainly as gaseous dimers. For the reaction

$2 \text{ KOH}(s) = \text{K}_2(\text{OH})_2(g) \Delta - H_{626}^0 = 36 \pm 2 \text{ kcal/mol}$ of dimer. The energy of dimerization of KOH(g) at $T = 626^\circ\text{K}$ is found to be greater than 38 kcal/mol of dimer. (Contractor's abstract)

COR.14:002

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

GASEOUS SPECIES IN THE VAPORIZATION OF SODIUM HYDROXIDE, by R. C. Schoonmaker and R. F. Porter. Nov. 4, 1957 [4]p. incl. diagr. tables, refs. (AFOSR-TN-57-681) (AF 18(603)1) AD 136870

Unclassified

Also published in Jour. Chem. Phys., v. 28: 454-457, Mar. 1958.

Mass spectrometric studies of the gaseous species in sodium hydroxide vapor have shown that in the temperature range 300°C to 450°C, liquid NaOH vaporizes mainly as gaseous dimers. A thermodynamic treatment of ion current data for the equilibrium reaction of liquid NaOH and gaseous $\text{Na}_2(\text{OH})_2$ yields a value of 28 ± 3

kcal/mol of dimer for the change in enthalpy at 660°K and for the equilibrium reaction of solid NaOH and gaseous NaOH the change in the enthalpy at 600°K is found to be -54 ± 5 kcal/mol of dimer. Comparison with existing data on the gaseous alkali halides shows the trend in dimerization energies: $\text{NaOH} > \text{NaCl} > \text{NaF}$. (Contractor's abstract, modified)

COR.14:003

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

GASEOUS SPECIES IN THE NaOH-KOH SYSTEM, by R. F. Porter and R. C. Schoonmaker. [1958] [4]p. incl. tables, refs. (AFOSR-TN-58-14) (AF 18(603)1) AD 148082

Unclassified

Also published in Jour. Phys. Chem., v. 62: 486-489, Apr. 1958.

Mass spectrometric studies of the gaseous species evaporating from NaOH-KOH mixtures show that in the temperature range 600 to 700°K the vapor consists of $\text{NaK}(\text{OH})_2$ molecules in addition to monomers and dimers of NaOH and KOH. Thermodynamic treatment of ion current data yields for the reactions $2\text{KOH}(g) = \text{K}_2(\text{OH})_2(g)$,

$\Delta H_{650^\circ\text{K}}^0 = 46.5 \pm 5 \text{ kcal/mol}$ of dimer; $\text{KOH}(s) =$

$\text{KOH}(g)$, $\Delta H_{298}^0 = 44.6 \pm 3 \text{ kcal/mol}$; and for $\text{Na}_2(\text{OH})_2(g) + \text{K}_2(\text{OH})_2(g) = 2\text{NaK}(\text{OH})_2(g)$, $\Delta H^0 \sim 0$.

COR.14:004

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

MASS SPECTROMETRIC STUDY OF FERROUS CHLORIDE VAPOR, by R. C. Schoonmaker and R. F. Porter. [1958] [5]p. incl. diagr. tables, refs. (AFOSR-TN-58-207) (AF 18(603)1) AD 152248

Unclassified

Also published in Jour. Chem. Phys., v. 29: 116-120, July 1958.

Mass spectrometric studies of the vaporization of ferrous chloride show that the major vapor species is monomeric $\text{FeCl}_2(g)$. A small concentration of $\text{Fe}_2\text{Cl}_4(g)$ is present

in the vapor at low temperatures. The ratio of dimer to monomer concentration increases rapidly with temperature showing that at the melting point of $\text{FeCl}_2(s)$, the

equilibrium vapor consists of about 25% dimer. Thermodynamic treatment of ion current data yields for the reaction $2\text{FeCl}_2(s) = \text{Fe}_2\text{Cl}_4(g)$, $\Delta H_{640^\circ\text{K}}^0 = 56 \pm 3 \text{ kcal/mol}$ of dimer, and for the reaction $\text{Fe}_2\text{Cl}_4(g) = 2\text{FeCl}_2(g)$,

$\Delta H_{640^\circ\text{K}}^0 = 32 \pm 3 \text{ kcal/mol}$ of dimer. (Contractor's abstract)

COR.14:005

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

MASS SPECTROMETRIC STUDY OF THE VAPORIZATION OF LiF, NaF, AND LiF-NaF MIXTURES, by R. F. Porter and R. C. Schoonmaker. [1958] [23]p. incl. tables, refs. (AFOSR-TN-58-687) (AF 18(603)1) AD 162221

Unclassified

Also published in Jour. Chem. Phys., v. 29: 1070-1074, Nov. 1958.

Vapors effusing from Knudsen cells containing LiF, NaF, and LiF-NaF mixtures were analyzed mass spectrometrically in the temperature range 900 to 1150°K. Monomers, dimers, and trimers of LiF and NaF were observed. The LiF system contained the higher concentration of dimers and trimers. In the LiF-NaF system: at 50 mol-% LiF, the mixed dimer, LiNaF_2 , was the major polymeric vapor species. Thermochemical data for $\text{LiF}(g)$, $\text{NaF}(g)$, $\text{Li}_2\text{F}_2(g)$, $\text{Na}_2\text{F}_2(g)$ and $\text{Li}_3\text{F}_3(g)$ were also obtained. For the reaction $\text{Li}_2\text{F}_2(g) + \text{Na}_2\text{F}_2(g) = 2\text{LiNaF}_2(g)$, ΔH^0 was approximately zero. (Contractor's abstract)

COR. 14:006-008; COR. 15:001

COR.14:006

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

A MASS SPECTROMETRIC STUDY OF THE VAPORIZATION OF FERROUS BROMIDE, by R. F. Porter and R. C. Schoonmaker. [1958] [12]p. incl. diagr. tables. (AFOSR-TN-58-900) (AF 18(603)1) AD 230884

Unclassified

Also published in Jour. Phys. Chem., v. 63: 626-628, Apr. 1959.

A mass spectrometer was used to analyze the vapors effusing from a Knudsen cell containing $\text{FeBr}_2(s)$. In

the temperature interval 620-665°K, the monomer is the predominant vapor species; but at the melting point, the dimer concentration becomes significant. Thermochemical data were determined for the reactions:

$2\text{FeBr}_2(s) = \text{Fe}_2\text{Br}_4(g)$, $\Delta H_{640}^0 = 59.5 \pm 6 \text{ kcal/mol}$ dimer; and $\text{Fe}_2\text{Br}_4(g) = 2\text{FeBr}_2(g)$, $\Delta H_{640}^0 = 34.7 \pm 4 \text{ kcal/mol}$ dimer. (Contractor's abstract)

COR.14:007

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

HEATS OF DIMERIZATION OF ALKALI FLUORIDE MOLECULES, by R. C. Schoonmaker and R. F. Porter. [1958] [12]p. incl. tables, refs. (AFOSR-TN-58-901) (AF 18(603)1) AD 230885

Unclassified

Also published in Jour. Chem. Phys., v. 30: 283-285, Jan. 1959.

A mass spectrometer was used to analyze vapors in equilibrium with alkali fluoride condensed phases. Monomers, dimers, and trimers were detected in all alkali fluoride vapors. In addition to monomers and dimers characteristic of pure condensed phases, mixed dimers were found in equilibrium with mixed condensed phases. A method for determining the difference in dimerization energies for constituents in a mixed vapor was formulated, and dimerization enthalpies for alkali fluoride species are presented. (Contractor's abstract)

COR.14:008

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

GASEOUS SPECIES IN THE VAPORIZATION OF SODIUM AND POTASSIUM HYDROXIDE, by R. F. Porter and R. C. Schoonmaker. [1958] [2]p. incl. diagr. table. (AFOSR-TN-58-1021) (AF 18(603)1) AD 162286

Unclassified

Also published in Jour. Chem. Phys., v. 28: 188-189, Jan. 1958.

Mass spectrometric studies of the gaseous species produced in the vaporization of NaOH and KOH have shown that in the temperature range 270°C to 450°C, the vapor phase of these compounds consists largely of dimer molecules. The gaseous species effusing from a Knudsen cell containing a condensed hydroxide phase were subjected to electron bombardment for subsequent ion detection in a 12-in. 60° direction-focusing mass spectrometer. Through a study of positive ions produced, appearance potentials, ion current ratios, and dependence of ion currents on experimental conditions the neutral molecular species in the vapor have been identified and thermochemical data have been obtained. (Contractor's abstract)

COR.15:001

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

INELASTIC MOLECULAR COLLISIONS WITH A MAXWELLIAN INTERACTION ENERGY, by B. Widom. Mar. 15, 1957 [45]p. incl. diagrs. table. (AFOSR-TN-57-129) (AF 18(603)111) AD 120485

Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 132, Mar. 21, 1957.

Also published in Jour. Chem. Phys., v. 27: 940-952, Oct. 1957.

The radial Schrödinger equation for arbitrary values of the angular momentum is solved exactly with a repulsive R^{-4} potential energy, the solutions being Mathieu functions whose arguments are linear functions of $\log R$. These solutions are then applied to the problem of vibrational relaxation in the distorted wave approximation. Emphasis is given to the case in which the energy which is exchanged in the inelastic collision, ϵ_0 , is very much greater than the smaller of the energies of the incident and emergent waves. It is found that in this case the energy exchange probability per collision is proportional to a sinusoidal factor which may have a value anywhere between 0 and 1, depending on the precise magnitude of ϵ_0 ; to a factor which decreases as the exponential of $\epsilon_0^{-1/2}$; and to a factor which depends on the angular momentum quantum number, l , and on the smaller of the incident and emergent wave numbers, k . This last factor is evaluated for fixed l with k^{-1} much less than the effective range of molecular interaction; for fixed l with k^{-1} much greater than the effective range; and for l large with k fixed. The relaxation time is obtained and both its magnitude and temperature dependence are discussed. Over an appropriate range of temperature it is found to decrease

COR. 15:002-004; COR. 18:001

as the exponential of $-T^{1/3}$, which is not the same as the Landau-Teller exponential of $T^{-1/3}$. The temperature dependence found in the present work is in better agreement with the observed high-temperature vibrational relaxation of oxygen, and essentially perfect agreement is obtained when the present approximation methods are applied with an exponential interaction energy. The magnitude of the relaxation time, however, is not predicted nearly so well as is its temperature dependence. (Contractor's abstract)

COR.15:002

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

CHARACTERISTIC EXPONENT FOR THE RADIAL WAVE EQUATION WITH A MAXWELLIAN POTENTIAL, by E. Drauglie and B. Widom. Sept. 15, 1957, 6p. incl. table. (AFOSR-TN-57-596) (AF 18(603)111) AD 136582
Unclassified

Also published in Jour. Chem. Phys., v. 28: 309-310, Feb. 1958.

A solution is given to the radial Schrödinger equation with a repulsive R^{-4} potential by means of the transformation to a standard Mathieu equation. The associated characteristic exponent in the Mathieu equation is an important parameter in determining the properties of the solution. Values of this exponent have been calculated for the six lowest angular momentum states and for a range of energies of interest in molecular dynamics. (Contractor's abstract, modified)

COR.15:003

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

RELAXATION OF THE STRING OSCILLATOR, by B. Widom. [1958] 26p. incl. diagr. (Technical note no. 3) (AFOSR-TN-58-12) (AF 18(603)111) AD 148051
Unclassified

Also published in Jour. Chem. Phys., v. 28: 918-925, May 1958.

A single collision between an oscillator and an impinging particle usually consists of a multiplicity of impacts. If the oscillator is a particle on an inextensible string (mechanically equivalent to a particle in a box), and if it interacts impulsively with particles of identical mass incident along its line of oscillation, then each collision either consists of a single impact, in which case momentum is exchanged, or of a double impact, in which case there is no net momentum exchange. The transition probability is calculated exactly, and the resulting integro-differential equation for the oscillator distribution function is solved explicitly. It is shown that the approach to equilibrium is

not in general exponential in the time, even in its last stages, but that it may be made so with a special initial distribution. The effect of impact multiplicity on the time of relaxation is discussed. (Contractor's abstract, modified)

COR.15:004

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

ONE-DIMENSIONAL INELASTIC COLLISIONS WITH IMPULSIVE INTERACTIONS, by B. Widom. [July 1958] [31]p. incl. diagrs. (AFOSR-TN-58-895) (AF 18(603)111) AD 162229
Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-28, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 140, Mar. 27, 1958.

Also published in Jour. Chem. Phys., v. 30: 238-245, Jan. 1959.

A linear oscillator interacting impulsively with a free particle incident along its line of oscillation will in general suffer a change in state; and this model may be taken to represent an inelastic molecular collision. It is pointed out that this picture is substantially equivalent to that used by Castellan and Hulburt, with one modification. The problem is formulated for both quantum and classical mechanics. Explicit transition probabilities are calculated for two extreme cases: (i) the mass and momentum of the incident particle are small, while its energy is fixed; (ii) the mass of the incident particle is small and its energy is large, while its momentum is fixed. The quantum form of approximation (i) is essentially the approximate theory of Castellan and Hulburt. In the present paper the emphasis is on approximation (ii), for which it is shown that in both the classical and quantum theories the average energy transferred to an oscillator of mass m by an incident particle of momentum p is $2p^2/m$, whatever the law of force of the oscillator and whatever its initial state. It is also shown in this approximation that the classical transition probability for the harmonic oscillator may be recast in a pseudoquantum form so as to allow direct comparison with the quantum mechanical transition probability over the whole range of momenta of the incident particle. (Contractor's abstract)

COR.16:001

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

THE FORMATION OF A DINUCLEAR Cr(III) SPECIES BY OXIDATION OF CHROMOUS SOLUTIONS, by M. Ardon and R. A. Plane. Oct. 23, 1958, 12p. incl. table, refs. (AFOSR-TN-58-936) (AF 49(638)279) AD 205090
Unclassified

COR.02:004 - COR.02:006

Also published in Jour. Amer. Chem. Soc., v. 18: 3197-3200, July 5, 1959.

The dissolved chromic species formed when chromous perchlorate is oxidized in aqueous solution by molecular oxygen is shown by visible spectrum and behavior toward a cation exchange resin to be the same as the hydrolytic polymer which forms first when chromic solutions are refluxed. Analysis of the solution for chromium, perchlorate, and free acid shows the species to have a charge of +2 per Cr atom. Ion exchange experiments indicate that +4 is the most likely charge for the entire species, which is consistent with its being a dinuclear Cr(III) species with the two Cr atoms bound by either an O or two OH bridges. This same product can be formed by oxidation of Cr^{++} with Ti^{+3} and in lower yield by ClO_3^- , HClO , Cr_2O_7 and H_2O_2 . It is absent when the oxidation is performed with Fe^{+3} , Cu^{++} , Cl_2 , or Br_2 . It is believed that the dimer results from reaction of the intermediate Cr(IV) with Cr^{++} . (Contractor's abstract)

COR.02:004

Cornell U. Dept. of Engineering Physics, Ithaca, N. Y.

INTERNAL FRICTION STUDIES IN IMPURITY-DOPED SINGLE COPPER CRYSTALS, by R. R. Stevens, Jr. Feb. 1, 1957, 50p. incl. diagr. tables. (Technical rept. no. 2) (AFOSR-TR-57-11) (AF 18(600)1000) AD 120411
Unclassified

The temperature dependence and amplitude dependence of the internal friction of impurity-doped single copper crystals was measured in the temperature range of 27°C to 900°C and in the strain amplitude range of 10^{-8} to 10^{-5} at frequencies in the kilocycle range. The method of measurement consisted in exciting reeds in transverse modes of vibration and then determining the decay time of the resulting free damped vibrations. The results obtained are compared with those of other investigators and are interpreted in the light of modern dislocation theories. (Contractor's abstract)

COR.02:005

Cornell U. Dept. of Engineering Physics, Ithaca, N. Y.

AN INVESTIGATION OF LOW TEMPERATURE INTERNAL FRICTION IN METALS, by H. L. Caswell. Sept. 1, 1957, iv. incl. illus. diagr. tables, refs. (Technical rept. no. 3) (AFOSR-TR-57-69) (AF 18(600)1000) AD 136597
Unclassified

Presented at Conference on Ultrasonic Energy Losses in Crystalline Materials, Brown U., Providence, R. I., Sept.

4-6, 1956 and at Canadian Metal Physics Conference, Kingston, Ont., Sept. 3-5, 1957.

Also published in part in Jour. Appl. Phys., v. 29: 1210-1214, Aug. 1958.

Equipment and techniques were developed for measuring the internal friction and Young's modulus of pure Cu crystals between 4° to 300°K by using longitudinal vibrations at a frequency of 38 to 42 kc. Measurements were also made on crystals containing various concentrations of Au or Ni. In the 99.99% pure, annealed, single crystals, the background decrement decreased monotonically with decreasing temperature. A sharper decrease near room temperature was observed in Au-doped annealed, single crystals, but not in the Ni-doped crystal. A peak at 180°K was observed in Au- or Ni-doped annealed reeds. Cold work generally increased the background decrement up to a 2% reduction after which it had little effect; the temperature dependence was less pronounced than in annealed crystals. The greatest amplitude dependence of the internal friction occurred in the pure, annealed, single Cu crystals. The addition of Au to Cu reduced the amplitude dependence appreciably. Ni produced the same result, but to a lesser degree than Au. Cold work also systematically reduced the amplitude dependence. The Bordoni peak is not present in annealed samples, either pure or doped. The peak is introduced by cold working the sample. Cross rolling had a more pronounced effect on the height of the peak than continued rolling in one dimension in excess of a 3% reduction. Increased cold work shifted the peak temperature to slightly higher values. Impurities of sufficient concentration decreased the peak height, shifted the peak temperature to slightly lower values, and increased the peak width. A second peak was observed in Cu samples at 40°K but was much smaller than the Bordoni peak. A peak at 20°K occurred in cross rolled Mg, but was not present in semi-annealed stock material. (ASTIA abstract)

COR.02:006

Cornell U. Dept. of Engineering Physics, Ithaca, N. Y.

A HORIZONTAL, CONTINUOUS FLOW CRYOSTAT, by H. L. Caswell. [July 1957] [3]p. incl. diagr. (AF 18-(600)1000)
Unclassified

During an investigation of internal friction at low temperatures, it was found desirable to have a cryostat in which samples of up to seven inches in length could be mounted horizontally and in which measurements could be made at controlled temperatures from 5°K to 370°K. Since certain temperature ranges were of special significance, it was important to be able to regulate the rate of increase or decrease of temperature and to cover the same ranges of temperature more than once at any time during the experiment. It has been found that conventional cryostats were not suitable for this

COR.02:007 - COR.02:010

application. A continuous flow cryostat having the desired characteristics was developed and is described in this report.

COR.02:007

Cornell U. Dept. of Engineering Physics, Ithaca, N. Y.

REMARKS ON THE THEORETICAL INTERPRETATION OF THE BORDONI PEAK (Abstract), by V. K. Paré. [1957] [1]p. (AF 18(600)1000) Unclassified

Presented at the Canadian Metal Physics Conference, Kingston, Ont., Sept. 5-7, 1957.

The most promising explanation of the Bordoni low-temperature internal friction peak is that of A. Seeger, since it predicts that the temperature at which the peak occurs should be independent of the treatment of the sample. However, it also predicts a much narrower peak than is observed, and a marked dependence on strain amplitude, also not observed. Various possible sources of broadening of the peak are considered, and it is shown that a distribution of activation energies must exist. The shape of the distribution is inferred from the data presented by H. L. Caswell in the previous paper. To explain this, a distribution of internal stresses is postulated, and is found to reduce the strain amplitude dependence and also provide a distribution of activation energies. The results are compared with Caswell's data. A brief discussion is given of the possibility of applying Seeger's more elaborate theory in this way. (Contractor's abstract)

COR.02:008

Cornell U. Dept. of Engineering Physics, Ithaca, N. Y.

SOME EXPERIMENTAL RESULTS ON THE BORDONI INTERNAL FRICTION PEAK IN COPPER (Abstract), by H. L. Caswell. [1957] [1]p. (AF 18(600)1000) Unclassified

Presented at Canadian Metal Physics Conference, Kingston, Ont., Sept. 5-7, 1957.

The effect of cold work and subsequent annealing on the height and shape of the Bordoni internal friction peak at about 80°K in a 99.999% pure single crystal of copper has been studied at a frequency of 40,000 cps. It was found that no peak was present in the annealed crystal, but that as the crystal was subjected to increasing amounts of cold work, higher peaks occurred. Those phenomena are independent of the stress amplitude. Subsequent annealing reduced the amplitude of the peak. The addition of small amounts of nickel and gold was found not to seriously effect the height or shape of the peak. The result of freezing in a surplus of vacancies was also investigated. (Contractor's abstract)

COR.02:009

Cornell U. Dept. of Engineering Physics, Ithaca, N. Y.

EXPERIMENTAL AND THEORETICAL STUDY OF LOW-TEMPERATURE INTERNAL FRICTION IN COPPER, by V. K. Paré. July 1, 1958, 1v. incl. illus. diagrs. tables, refs. (Technical rept. no. 4) (AFOSR-TR-58-92) (AF 18(600)1000) AD 162133; PB 138958 Unclassified

Measurements were made of internal friction in cold-worked copper single crystals as a function of temperature from 4°K to 300°K and at strains ranging from 10^{-7} to 2×10^{-5} . Flexural vibration was used at frequencies in the neighborhood of 5 kc. Particular attention was given to the Bordoni peak, a prominent maximum at about 80°K in the curve of internal friction versus temperature, apparently representing a thermally-activated relaxation process. The activation energy of the process was estimated as 0.18 ev by comparison of the data with that of other investigators at different frequencies. A theory of Seeger, Donth, and Pfaff is discussed which describes the interactions of dislocations with thermal stress waves and with the periodic potential giving rise to the Peierls force. The applicability of this theory and of some modifications introduced by the author is shown in terms of the activation energy and breadth of the Bordoni peak, and its dependence on the amplitude of oscillating strain employed in the measurement. (Contractor's abstract, modified)

COR.02:010

Cornell U. [Dept. of Engineering Physics] Ithaca, N. Y.

INTERNAL FRICTION IN COPPER SINGLE CRYSTALS AT LOW TEMPERATURES (Abstract), by V. K. Paré, T. R. Cuykendall, and H. S. Sack. [1958] [1]p. (AF 18(600)1000) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 122, Mar. 27, 1958.

The internal friction maximum first observed by Bordoni at about 80°K is of interest because it may provide information on lattice barriers to dislocation motion. Results of measurements on cold-worked copper single crystals vibrated at 4 kc are described and compared with the 40 kc data of Caswell (item no. COR.02:005) on some of the same samples. The effects of frequency, mode of deformation, impurities, and aging on the position, height, and shape of the peak are discussed. The theory of Seeger, Donth, and Pfaff predicts the correct general behavior but gives a peak which is

much too narrow and shifts with changes in strain amplitude. Taking into account the internal stresses in cold-worked metal eliminates the latter effect and broadens the peak in a way which depends on the relaxation model used.

COR.05:060

Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

THE FINITE CONVOLUTION TRANSFORM, by J. Blackman and H. Pollard. Aug. 1957, 14p. (Rept. no. 65) (AFOSR-TN-57-52) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-685 and Office of Naval Research) AD 136442; PB 135988 Unclassified

Also published in Trans. Amer. Math. Soc., v. 91: 399-409, June 1959.

A complete solution is found of the integral equation

$$f(x) = \int_0^x \gamma(s-t)dk(t), \quad 0 \leq x < a$$

where f and k are given and γ is to be determined. The method consists in convolving f with suitable convolutions of infinite order. (Contractor's abstract)

COR.05:061

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

ON THE PHRAGMÉN-LINDELÖF THEOREM AND SOME APPLICATIONS, by H. Rademacher. Aug. 1957, 20p. (Rept. no. 66) (AFOSR-TN-57-453) (AF 18(600)-685) AD 136443; PB 135990 Unclassified

Also published in Math. Zeitschr., v. 72: 192-204, 1959.

The Phragmén-Lindelöf theorem for a parallel strip is usually enunciated for a single function and contains a multiplicative constant possibly depending on the function. Here a statement of the theorem is evolved which is valid uniformly for an infinite set of functions and which is sharp. The basic idea is to use a special subharmonic function for a lower estimate of a harmonic function. Applications are made to families of $L(s, \chi)$ - and $\xi_k(s)$ -functions with new results.

COR.05:062

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

THE PHRAGMÉN-LINDELÖF THEOREM AND SUBHARMONIC FUNCTIONS, by H. Rademacher. Aug. 1957, 9p. (Rept. no. 67) (AFOSR-TN-57-457) (AF 18(600)-685) AD 136448 Unclassified

The method used in a previous paper on the Phragmén-Lindelöf theorem is applied to some other boundary conditions. The prescribed growth functions in the resulting theorems form successive steps of a logarithmic scale. The existence theorem in this paper is treated by means of the Poisson formula. (Contractor's abstract)

COR.05:063

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

NON-ABELIAN COHOMOLOGY AND VAN KAMPEN'S THEOREM, by P. Olum. Aug. 1957, 18p. incl. diagrs. (Rept. no. 68) (AFOSR-TN-57-485) (AF 18(600)-685) AD 136478 Unclassified

Also published in Ann. Math., v. 68: 658-668, Nov. 1958.

This paper has two purposes. In the first place, it develops material on cohomology with nonabelian coefficients needed for later work in the homotopy classification of mappings; included in this is a Mayer-Vietoris sequence for nonabelian cohomology. Secondly, as an application of the Mayer-Vietoris sequence, it gives a new proof of (and generalizes considerably) the van Kampen theorem on the fundamental group of the union of two topological spaces. (Contractor's abstract)

COR.05:064

Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

AN EXTREMUM PROBLEM, by H. Widom. Sept. 1957, 12p. (Rept. no. 69) (AFOSR-TN-57-536) (AF 18(600)-685) AD 136522; PB 135984 Unclassified

Let $f(\theta)$ be non-negative and integrable on $(-\pi, \pi)$, and $|a| < 1$. G. Szego has shown that the infimum of

$$(1) \quad \frac{1}{2\pi} \int_{-\pi}^{\pi} |P(e^{i\theta})|^2 d\theta,$$

taken over all polynomials P with $P(a) = 1$ is given by

$$(2) \quad \exp\left(\frac{1}{2\pi} \int_{-\pi}^{\pi} \log f(\theta) \frac{1-p^2}{1-2p \cos(\theta-\gamma) + p^2} d\theta\right)$$

where $pe^{i\gamma} = a$. In this paper the following result was: Let L be a linear functional on the space of polynomials; then we find the infimum of (1) taken over all P with $L(P) = 1$. The actual form of the result is somewhat complicated (in fact the formula takes different forms depending on the behavior of f and L) but (2) drops out of it quite easily. (Contractor's abstract)

COR.05:065 - COR.05:070

COR.05:085

Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

MANY-VALUED LOGICS, by J. B. Rosser. Oct. 1957, 3p. (Rept. no. 70) (AFOSR-TN-57-829) (AF 18(800)-685) AD 138814 Unclassified

A summary is presented of a talk given on July 2, 1957 at the Summer Institute in Symbolic Logic at Cornell University. The talk reviewed the existing literature on many-valued logics and expounded new results, as yet unpublished.

COR.05:068

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

THE RELATION BETWEEN TURING MACHINES AND ACTUAL COMPUTING MACHINES (Abstract), by R. J. Barkley. Oct. 1957 [2]p. (AFOSR-TN-57-630) (AF 18(800)885) AD 138815 Unclassified

This is a summary of a talk given at the Logic Institute on July 9. Theoretical studies of computing machinery are usually based on an idealized type of machine, known as a Turing machine. On the basis of a comparison of Turing machines with actual machines, it is concluded that this sort of theoretical study is justified.

COR.05:087

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

REAL ROOTS OF DIRICHLET L-SERIES, II, by R. J. Barkley. Oct. 1957, 31p. incl. tables. (AFOSR-TN-57-631) (AF 18(600)685) AD 136618 Unclassified

We consider a real character $\chi \pmod{k}$ and the corresponding L-series, $L(s, \chi)$. We show that for $k \leq 986$ there are no positive zeros of $L(s, \chi)$ and that for $k \leq 40,000$ there are no zeros ρ with $0.99 < \rho$. These results have important applications to the distribution of primes in arithmetic progressions. (Contractor's abstract)

COR.05:068

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

SPECTRAL SYNTHESIS FOR THE CIRCLE, by C. S. Herz. Nov. 1957, 7p. (Rept. no. 73) (AFOSR-TN-57-694) (In cooperation with Institute for Advanced Study, Princeton, N. J.) (AF 18(600)685) AD 136687; 1B 135980 Unclassified

Also published in Ann. Math., v. 68: 709-712, Nov. 1958.

Spectral synthesis holds for the (circumference of the)

unit circle in Euclidean R^2 . (Contractor's abstract)

COR.05:089

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

A WIENER-HOPF EQUATION OF THE FIRST KIND, by H. Pollard and H. Widom. Dec. 1957, 8p. (Rept. no. 74) (AFOSR-TN-57-750) (AF 18(800)885) AD 136738 Unclassified

A solution is given of the Wiener-Hopf equation

$$f(x) = \int_0^{\infty} k(y)\omega(x+y)dy, \quad x > 0 \text{ under the assumptions}$$

- (1) $k \in L(0, \infty)$; (2) $k \neq 0$ in the neighborhood of zero;
- (3) the Laplace transform $K(s) = \int_0^{\infty} e^{-sx}k(x)dx$ has no zeros in the closed right hand-plane; and (4) $\omega \in L_p(0, \infty)$ for some p in $1 \leq p \leq 2$.

COR.05:070

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

A THEOREM ON POWER SERIES WHOSE COEFFICIENTS HAVE GIVEN SIGNS, by W. H. J. Fuchs. [1957] [7]p. (AF 18(600)685) Unclassified

Published in Proc. Amer. Math. Soc., v. 8: 443-449, June 1957.

The well-known theorem of Hurwitz and Pólya (Acta Math., v. 40: 179-183, 1915) says that if $\sum a_k z^k$ is a power series with finite radius of convergence then it is possible to find a sequence $\{e_k\}$ ($e_k = \pm 1$) such that the series $\sum e_k a_k z^k$ has the circle of convergence as natural boundary. In the present paper the following sort of converse to the above results is proven. If $\{e_k\}$ is a sequence with $e_k = \pm 1$ then there is always a power series $\sum a_k z^k$, $a_k > 0$, of finite radius of convergence such that the series $\sum e_k a_k z^k$ can be analytically continued across a semi-circle on its circle of convergence. It is shown that the semi-circle cannot be replaced by a larger arc. It remains an open question to find a corresponding theorem for the case in which e_k is a given sequence of complex numbers of absolute value one. (Math. Rev. abstract)

COR.05:071 - COR.05:075

COR.05:071

[Cornell U. Dept. of Mathematics, Ithaca, N. Y.]

SINGULAR INTEGRAL OPERATORS, AND DIFFERENTIAL EQUATIONS, by A. P. Calderón and A. Zygmund. [1957] [21]p. (AF 18(600)685) Unclassified

Published in Amer. Jour. Math., v. 79: 901-921, Oct. 1957.

Let $P(u)$ be a linear partial differential operator with smooth coefficients and of homogeneous order m . Then

$P = H\Lambda^m$ where Λ is a square root of the Laplacian and H is a singular operator. With each singular integral operator there is associated a function in a one-to-one fashion. This correspondence is linear and pseudo-multiplicative in the sense that, modulo a class of regular operators, singular integral operators can be multiplied (in the sense of operator composition) by simply multiplying their symbols. The regular operators in that class have the property of remaining bounded after being multiplied on the left or on the right by Λ . A detailed study is presented of the properties of singular integral operators in their connection with the operator Λ .

COR.05:072

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

ON THE PARTITION FUNCTION OF A ONE-DIMENSIONAL GAS, by M. Kac. Mar. 1958 [10]p. (Rept. no. 75) (AFOSR-TN-58-201) (AF 18(600)685) AD 152234; PB 140050 Unclassified

Also published in Phys. Fluids, v. 2: 8-12, Jan.-Feb. 1959.

The grand-partition function of a one-dimensional gas is calculated with the potential $V(x)$ given by the formula

$$V(x) = \begin{cases} +\infty, & 0 < x < \delta, \\ -ae^{-\gamma x}, & x \geq \delta. \end{cases}$$

The crucial feature of the potential responsible for the success of the calculation is that $e^{-\gamma|x|}$ is the correlation function of a stationary, Gaussian, Markoffian process (the Ornstein-Uhlenbeck process).

COR.05:073

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

OPTIMUM DESIGNS IN REGRESSION PROBLEMS, by J. Kiefer and J. Wolfowitz. Feb. 1959, 35p. incl. refs. (Rept. no. 79) (AFOSR-TN-58-389) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)685 and Office of Naval Research) AD 154298; PB 140048 Unclassified

Also published in Ann. Math. Stat., v. 30: 271-294, June 1959.

Computational procedures are developed for finding optimum designs in regression problems of estimation and testing hypotheses. The theory is developed for the case where the desired inference concerns just one of the regression coefficients; illustrative examples are given. The theory for the case of interference on several coefficients is also developed. The problem of global estimation is treated for the regression function rather than that of the individual coefficients.

COR.05:074

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

INVERSION OF TOEPLITZ MATRICES, by A. [P.] Calderón, F. Spitzer, and H. Widom. Mar. 1958, 16p. (Rept. no. 76) (AFOSR-TN-58-489) (AF 18(600)685) AD -58297; PB 140047 Unclassified

Also published in Illinois Jour. Math., v. 3: 490-498, Dec. 1959.

Conditions are found for the invertibility of the Toeplitz matrix $T = (c_{j-k})$, $j, k = 0, 1, \dots$. In case $\sum_{k=0}^{\infty} |c_k| < \infty$, T is a bounded operator on the space of bounded sequences and a necessary and sufficient condition for the invertibility of T is found, and the matrix T^{-1} is produced. As a consequence of the theory a Tauberian theorem is proved. In case $\sum_{k=0}^{\infty} c_k e^{ik\theta}$ is in $L_{\infty}(-\pi, \pi)$, T is a bounded operator on the space of square summable sequences and a sufficient condition is found for the invertibility of T . (Contractor's abstract)

COR.05:075

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

MINIMAX FUNCTIONS, CONFIGURATION FUNCTIONS AND PARTITIONS, by R. P. Agnew. May 1958, 27p. incl. tables. (Rept. no. 77) (AFOSR-TN-58-490) (AF 18-(600)685) AD 158298; PB 140068 Unclassified

Two classes of functions defined by R. W. Murphy (IBM Jour. Research and Development, v. 1: 158-170, 1957) are investigated: class F_n of minimax functions, and class G_n of functions called configuration functions. Each function is continuous of F_n and in G_n . When $n > 2$, G_n contains discontinuous as well as continuous functions. Proof is presented of Murphy's conjecture that each continuous function in G_n is continuous in F_n so that $F_n = CG_n$ where C is the class of continuous

COR.05:076 - COR.05:078

functions, and the results show how the values of a function g in CG_n determines the f in F_n to which it is equal. A partition problem which was originated by Dedekind and which is related to the determination of the number of free distribution lattices having n generators is presented.

COR.05:076

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

ON RAPIDLY MIXING TRANSFORMATIONS AND AN APPLICATION TO CONTINUED FRACTIONS, by M. Kac and H. Kesten. June 1958, 5p. (Rept. no. 78) (AFOSR-TN-58-491) (AF 18(600)685) AD 158299

Unclassified

Also published in Bull. Amer. Math. Soc., v. 64: 283-287, Sept. 1958.

Proof is presented of the theorem: Let Ω be a measure space (of total measure 1) and let T be a measure preserving transformation in the sense that $\mu(T^{-1}(A)) = \mu(A)$, where $T^{-1}(A)$ denotes the inverse image of A (not assuming that T is necessarily one-to-one). Let

$$V(\omega) = \begin{cases} 1, & \omega \in B \\ 0, & \omega \notin B \end{cases} \text{ and consider } \sum_{k=1}^n V(T^k \omega).$$

Under suitable conditions on T , the conditional measure

$$\mu \left\{ \frac{\sum_{k=1}^n V(T^k \omega)}{n} - \mu(B) < \frac{\sigma}{\sqrt{n}}, \omega \in B \right\}$$

approaches, as n tends to infinity, $\frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-\frac{u^2}{2\sigma^2}} du$

where σ is, in general, not known explicitly. The condition imposed on T is that of exponential rapid mixing. If ν is a measure absolutely continuous with respect to the invariant measure μ then, for every measurable set A , $|\nu(T^{-k}(A)) - \mu(T^{-k}(A))| =$

$$|\nu(T^{-k}(A)) - \mu(A)| \leq H_\nu e^{-\epsilon k} \mu(A),$$

where $\epsilon > 0$ is an absolute constant and H_ν a constant which may depend on the measure ν . (ASTIA abstract)

COR.05:077

Cornell U. Dept. of Mathematics, Ithaca, N. Y.

THE MAXIMUM ACHIEVABLE LENGTH OF AN ERROR CORRECTING CODE, by J. Wolfowitz. [1958] [5]p. (AFOSR-TN-58-533) (In cooperation with Technion-Israel Inst. of Tech., Haifa) (AF 18(600)685) AD 158349

Unclassified

Also published in Illinois Jour. Math., v. 2: 454-458, Sept. 1958.

The author uses results described in previous articles (Ill. Jour. Math., v. 1: 591-606, 1957, and Ill. Jour. Math., v. 2: 137-141, 1958) to obtain bounds for the size of an error-correcting block code in a discrete channel with memory m . The bounds do not involve the statistical nature of a source feeding to the channel. That is, there exists a functional J of the channel error probabilities which has the following property. Let $\epsilon > 0$ and $\lambda > 0$ be arbitrary, and let n be sufficiently large. Then there exists a block code of block length n which handles $2^{n(J-\epsilon)}$ code sequences with probability of error less than λ each, but no code of block length n and error bound λ contains more than $2^{n(J+\epsilon)}$ code sequences. If the channel capacities for independent [Markov, ergodic stationary] sources are C_0, C_1, C_2 , respectively, then $C_0 \leq C_1 \leq C_2 \leq J$. The author conjectures that $C_1 < J$ when $m > 1$. He reduces the problem for $m > 0$ to the memoryless case ($m = 0$) by considering subblocks of suitable length and discarding the small fraction (essentially, ϵ in $J \pm \epsilon$) of received symbols at the end of each subblock which produce memory between subblocks. Thus the spread of $O(1)$ of bounds for the case $m > 0$ is larger than the corresponding spread $O(n^{-1/2})$ the author has obtained in the case $m = 0$ [above references]. (Math. Rev. abstract)

COR.05:078

Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

ASYMPTOTIC MINIMAX CHARACTER OF THE SAMPLE DISTRIBUTION FUNCTION FOR VECTOR CHANGE VARIABLES, by J. Kiefer and J. Wolfowitz. [1958] [27]p. (AFOSR-TN-58-534) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)685 and Office of Naval Research) AD 158350

Unclassified

Also published in Ann. Math. Stat., v. 30: 463-489, June 1959.

The authors, in a joint paper with (Dvoretzky, Kiefer, and Wolfowitz, Ann. Math. Statistics, v. 27: 642-669, 1956) have shown that for a very general class of weight functions the sample distribution is an asymptotically minimax estimator of the distribution of a real valued random variable. In the present paper similar results

COR.05:079 - COR.05:081

are obtained for (finite dimensional) vector-valued random variables. The method of the quoted paper must be greatly modified since the "distribution-free" properties of the sample d.f. no longer hold. The authors utilize their previous results (Trans. Amer. Math. Soc., v. 87: 173-186, 1958) on the deviation of the sample d.f. from the true d.f. in the multi-dimensional case. From the uniformity of approach of the d.f. of the normalized maximum deviation to its limit the authors deduce the existence of an approximately least favorable distribution and proceed hence to prove the following result: Let $W(r)$, for $r \geq 0$, be continuous, non-negative, non-decreasing, not identically zero and satisfy (*) $\int_0^\infty r W(r) e^{-c_m r^2} dr < \infty$ (c_m being a positive constant depending only on m); then the sequence of sample d.f. is asymptotically minimax relative to the sequence of weight functions

$$W_n(F, g) = W(n^{-1} \sup_z |g(z) - F(z)|)$$

and the family of all m -dimensional d.f. F . A similar result with c_m replaced by 2, is proved for integral weights $W_n(f, g) = \int W(n^{-1} F(x) - g(x)) dx$. Generalizations to other loss functions, etc., are indicated. (Math. Rev. abstract)

COR.05:079

Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

UNIQUENESS IN THE CAUCHY PROBLEM FOR PARTIAL DIFFERENTIAL EQUATIONS, by A. P. Calderón. [1958] [21]p. Incl. refs. (AF 18(600)685) Unclassified

Published in Amer. Jour. Math., v. 80: 16-35, Jan. 1958.

The problem of distinguishing all the types of partial differential equations, whose solutions are uniquely determined by Cauchy data, is of widespread current interest. In the paper under review, considerable advances are made in the general solution of this problem on the hypothesis that the (real and complex) characteristics of the equations considered are non-multiple. Linear equations first are considered, then systems of linear equations, and finally non-linear equations and systems reduced by well known methods to the linear case. The smoothness required of the coefficients in the linear cases, and of the differential equations in the non-linear cases, is light. Uniqueness in Cauchy's problem then is established for second and third order equations in any number of independent variables (the second order case is already known from Aronszajn, Jour. Math. Pures Appl., v. 36: 235-249, 1957), for equations of any order not in three independent variables, and for systems of equations not in three or four independent variables. The method is based on the fact that a linear differential operator Au of homogeneous order m defined on all Euclidean space and with bounded coefficients is

representable as $Au = \Delta^m u$, where Δ is a square root of the negative of the Laplacian, and H is a singular integral operator. This fact, in the light of properties of Δ and H previously established by Calderón and Zygmund (Amer. Jour. Math., v. 79: 901-921, Oct. 1957), makes possible the reduction of the uniqueness problem to a relatively simple form. (Math. Rev. abstract)

COR.05:080

Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

ASYMPTOTIC DISTRIBUTION OF STOCHASTIC APPROXIMATION PROCEDURES, by J. Sacks. [1958] [33]p. Incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)685] and Office of Naval Research) Unclassified

Published in Ann. Math. Stat., v. 29: 373-405, June 1958.

The asymptotic behavior is studied of the Robbins-Munro and Kiefer-Wolfowitz procedures. The result concerning Robbins-Munro is reproduced. Let: (1) $M(x)$ be Borel-measurable, $(x - \theta)(M(x) - \alpha) \geq 0$ and $|M(x) - \alpha| < K|x - \theta|$ for all x , $M(x) = \alpha + \alpha_1(x - \theta) + o(|x - \theta|)$ as $x \rightarrow \theta$, with $\alpha_1 > 0$ and $\inf |M(x) - \alpha| > 0$ over every compact interval not containing θ ; (2) $Z(x)$ be, for every x , a random variable, $\sup_x Z(x) < \infty$, $EZ^2(x) = \sigma^2$ as $x \rightarrow \theta$ and $\lim_{R \rightarrow \infty} \lim_{\epsilon \rightarrow 0} \sup_{|x - \theta| < \epsilon} \int_{|Z(x)| > R} Z^2(x) dP = 0$; (3) $a_n = A/n$ with $A > 1/(2\alpha_1)$. Then if $EX_1^2 < \infty$ and $X_{n+1} = X_n - a_n[M(X_n) - \alpha + Z(X_n)]$, it follows that $n^{1/2}(X_n - \theta)$ is asymptotically normally distributed with mean 0 and variance $A^2 \sigma^2 / (2A\alpha_1 - 1)$. The first results of this nature were proved by K. L. Chung [Ann. Math. Stat., v. 25: 463-483, 1954]. Chung and his followers used the method of moments; this paper utilizes instead a central limit theorem for dependent random variables and this enables him to obtain asymptotic normality under more general conditions than hitherto. Some remarks on "best possible" aspects of the results are made and the multidimensional case is also treated. (Math. Rev. abstract)

COR.05:081

Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

INVERSION OF AN INTEGRAL TRANSFORM, by H. Folland and H. Widom. [1958] [5]p. (AF 18(600)685) Unclassified

Published in Proc. Amer. Math. Soc., v. 9: 598-602, Aug. 1958.

COR.05:082; COR.07:017-019

Inversion formulas are given for the integral transformation

$$f(x) = \int_0^{\infty} k(y)\varphi(x+y)dy \quad (x > 0)$$

under the conditions that $k \in L(0, \infty)$; $k \neq 0$ near 0; $\varphi \in L_p(0, \infty)$ for some p in $1 \leq p \leq 2$; and the transform

$$K(s) = \int_0^{\infty} e^{-sx} k(x) dx \neq 0 \text{ has no zeros in the closed}$$

right half-plane. The conclusions are:

$$\varphi(x) = \lim_{\delta \rightarrow 0+} \lim_{\epsilon \rightarrow 0+} \frac{1}{2\pi} \int_0^{\infty} f(x+y) dy \int_{-\infty}^{\infty} \frac{e^{it(y-\delta)-\epsilon|k|}}{K(it)} dt,$$

and

$$c(x) = \lim_{\delta \rightarrow 0+} \lim_{\epsilon \rightarrow 0+} \frac{1}{2\pi} \int_0^{\infty} f(x+y) dy \int_{-\infty}^{\infty} \frac{1 - e^{-i\delta t} e^{ity - \epsilon|k|}}{it K(it)} dt$$

for almost all x and, in particular, at all points of right-continuity of c .

COR.05:082

Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

A THEOREM ON THE NEVANLINNA DEFICIENCIES OF MEROMORPHIC FUNCTIONS OF FINITE ORDER, by W. H. J. Fuchs. [1958] [7]p. (AF 18(600)685)

Unclassified

Published in Ann. Math., v. 68: 203-209, Sept. 1958.

The author proves the following theorem. Let $f(z)$ be a meromorphic function of finite lower order λ , and set $q = \max(2, \lambda)$. Then if δ_k are the defects in the sense of Nevanlinna, we have $\sum (\delta_k)^{\frac{1}{q}} \leq (Aq \log q)^{\frac{1}{q}}$. No other inequality of such generality is known, apart from the Nevanlinna defect relation $\sum \delta_k \leq 2$. The author states that an example of A. A. Goldberg [Dokl. Akad. Nauk. SSR, v. 98: 893-895, 1954] can be modified to show that the index q cannot be replaced by any smaller number. Also $q \log q$ cannot be replaced by anything smaller than q . The proof is surprisingly simple and depends on an estimation of the variation of $\log |f(z)|$ on the circle $|z| = r$. (Math. Rev. abstract)

COR.07:017

Cornell U. Dept. of Physics, Ithaca, N. Y.

ELECTRONIC BAND STRUCTURE OF SOLIDS BY THE METHOD OF EXPERIMENTAL X-RAY SPECTROSCOPY, by L. G. Parratt. June 25, 1958, 1v. incl. diagrs. refs. (Technical rept. no. 8; Revision of AFOSR-TN-56-562a) (AFOSR-TN-57-617) (AF 18(600)300)

AD 207519

Unclassified

Also published in Rev. Modern Phys., v. 31: 616-645.

July 1959.

Also published in Methods of Experimental Physics, N. Y., Academic Press, v. 6 (Part B): 281-292, 1959.

A review of the theory and experimental results on the x-ray methods for the determination of the electronic band structure of solids is given. The x-ray energy level diagram is discussed and the role of x-ray excitation states considered. The absorption spectra, widths of the lines and lifetimes of the x-ray states are presented. Experimental data are presented for the metals Na, Mg, Al, Ni, Cu, and Zn. The insulator KCl is discussed in detail.

COR.07:018

Cornell U. Dept. of Physics, Ithaca, N. Y.

THE ENERGY GAP BETWEEN THE VALENCE BAND AND THE CONDUCTION CONTINUUM IN THE ALKALI HALIDES, by E. L. Jossem. Oct. 20, 1957, 14p. incl. diagrs. (Technical rept. no. 9) (AFOSR-TN-57-640) (AF 18(600)300) AD 136627

Unclassified

Information was obtained on the magnitude of the energy gap between the valence band and the conduction continuum by interpreting experimental results from absorption and photoelectric measurements in the UV region and from x-ray emission and absorption measurements. Consideration is given to KCl and other alkali chlorides with respect to energy gaps.

COR.07:019

Cornell U. Dept. of Physics, Ithaca, N. Y.

STUDY OF THIN VACUUM DEPOSITED COPPER FILMS BY X-RAY TOTAL REFLECTION, by N. J. Scott. Dec. 30, 1957, 1v. incl. illus. diagrs. tables, refs. (Technical rept. no. 11) (AFOSR-TN-57-779) (AF 18(600)300) AD 148010

Unclassified

X-ray reflection curves were recorded and analyzed as a function of heat-treatment for thin Cu films of nominal thicknesses 35, 75, 120, 150, and 200A. The films were evaporated onto glass substrates; both Pyrex and soft glass substrates were used. The soft glass exhibited a surface layer of reduced density, about 50A of 20% reduction; for Pyrex glass, there was little if any such evidence. Fresh Cu films on soft glass showed an intensity minimum near ψ_c , the cut-off angle bounding the

region of total reflection. Films on Pyrex did not show this minimum, possibly due to the difference in the substrate surface and in its influence on the film structure. As a function of the heat-treatment up to 400°C, the general trend in the shapes of the curves and in the values of ψ_c were similar. For the 120A and 150A

films, initial treatments up to 100°C caused ψ_c to decrease

COR.07:020 - COR.07:023

slowly. After treatment at 130°C, ϕ_1 decreased rapidly to a value well below that predicted for Cu_2O or CuO . For the 75 Å films, the rapid decrease in ϕ_1 occurred at about 100°C. Continued heat-treatments above about 200°C caused ϕ_1 to increase slightly to an apparent saturation value. At about 300°C, a ϕ_1 pronounced low angle minimum developed in the reflected intensity for films on soft glass and became progressively deeper with additional heat-treatments. Reflection curves for thick-fresh Cu, Al and Au are discussed with respect to the determination of the dispersion constants used in the theoretical calculations. (ASTIA abstract)

COR.07:020

Cornell U. [Dept. of Physics] Ithaca, N. Y.

CORRECTION OF COMPLEX SPECTRA FOR INSTRUMENTAL RESOLVING POWER. PART II (Abstract), by J. O. Porteus and L. G. Parratt. Feb. 1, 1957 [1]p. [AF 18(600)300] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 55, Jan. 30, 1957.

In Part I (item no. COR.07:013) the general problem is stated and a solution outlined for certain model windows. For Part II, a different solution is given, one having greater practical generality. The observed spectrum is regarded as a superposition of the true spectrum and a perturbation function. The present solution is practical in almost all actual cases; however two formal conditions must be met: (a) a unique solution must exist and (b) the perturbation function must be expressible as a series of "correction functions" having uniformly decreasing amplitudes. These correction functions are calculated directly by taking successive "folds" (convolutions) of the spectral window (assumed to be known) with the observed spectrum. The calculation can be readily performed on a digital-type computer, or even on a desk calculator if a low order of correction is satisfactory. Estimates of the accuracy of the corrected spectrum, point by point, are provided by the correction functions themselves. Illustrative examples are given for an ideal simple spectrum and for complex x-ray emission and absorption spectra as observed with a two-crystal spectrometer.

COR.07:021

Cornell U. Dept. of Physics, Ithaca, N. Y.

NOTES ON THE PROSPECTIVE USE OF THE ORBIT-RADIATION OF A HIGH-ENERGY SYNCHROTRON IN

X-RAY PHYSICS IN THE 0.1 TO 20 Å REGION, by L. G. Parratt. May 1, 1958 [13]p. incl. diagrs. table. (Technical rept. no. 12) (AFOSR-TN-58-473) (AF 18(600)300) AD 158284 Unclassified

Also published in Rev. Scient. Instruments, v. 30: 297-299, Apr. 1959 (Title varies).

It is proposed to use the "very costly" orbit radiation for irradiation experiments, structure analysis, fluorescence spectroscopy, radiography, etc. This radiation, which is a waste product of a synchrotron, is shown theoretically to be much more intense for a 6 bev machine than the x-rays obtained from conventional x-ray tubes. For the 1 bev machine the orbit radiation is of about the same intensity as that from a conventional tube for wavelengths of about 1 Å. For longer wavelengths the intensity of advantage goes up rapidly until at 10 Å it is about 10^4 .

COR.07:022

Cornell U. Dept. of Physics, Ithaca, N. Y.

A STUDY OF EVAPORATED ALUMINUM FILMS BY X-RAY TOTAL REFLECTION, by R. C. Duncan and L. G. Parratt. Aug. 21, 1958, [100]p. incl. illus. diagrs. tables, refs. (Technical rept. no. 13) (AFOSR-TN-58-680) (AF 18(600)300) AD 162212; PB 137433

Unclassified

The nature of the surface of thick aluminum films evaporated onto glass substrates has been studied by the method of total reflection of x-rays. Films freshly deposited, then heat treated in successive steps up to 400°C or anodized in successive steps up to an oxide thickness of about 625 Å, have been studied. Details of the alignment of the reflectometer and of the preparation and treatment of the films are given. The theory of reflection based on homogeneous media accounts reasonably satisfactorily for the shape of the reflection curves near the critical angle for total reflection, but it seems necessary for the heat treated and anodized films to introduce a surface model which contains inhomogeneities in order to account for the shapes of the curves at smaller glancing angles. X-ray small-angle scattering from such inhomogeneities is discussed. (Contractor's abstract)

COR.07:023

Cornell U. Dept. of Physics, Ithaca, N. Y.

X-RAY ABSORPTION COEFFICIENTS AND GEOMETRICAL COLLIMATION OF THE BEAM, by L. G. Parratt, J. O. Porteus and others. Sept. 1, 1958, 14p. incl. diagrs. table, refs. (Technical rept. no. 14) (AFOSR-TN-58-755; (AF 18(600)300) AD 201614; PB 138143 Unclassified

COR.07:024 - COR.07:027

Also published in Rev. Scient. Instruments, v. 30: 344-347, May 1959.

In order to achieve high angular collimation of an intense x-ray beam in a measurement of an absorption coefficient, most investigators have used the action of a high-resolving-power monochromator to provide the collimation. If the absorber exhibits small-angle scattering (including multiple scattering) of significant intensity in a scattering cone as large as a few seconds of arc, the value of the coefficient depends upon the absorber-position with respect to the monochromator. A few measurements are reported with a two-crystal spectrometer to illustrate the points discussed. (Contractor's abstract)

COR.07:024

Cornell U. Dept. of Physics, Ithaca, N. Y.

THEORY OF SCATTERING OF X-RAYS AT ULTRA-SMALL ANGLES, by A. W. K. Metzner and L. G. Parratt. Sept. 14, 1958, 28p. incl. diagrs. tables, refs. (Technical rept. no. 15) (AFOSR-TN-58-780) (AF 18-(600)300) AD 202001; PB 137537 Unclassified

The theory of small-angle x-ray scattering was developed mathematically with an attempt to clarify the picture in the ultra-small-angle region. Interparticle interference effects are observed to play a dominant role. The theory of small-angle scattering as developed is somewhat equivocal about this ultra-small angular region, the region within about 10 sec of arc of the axis of symmetry. No theory based on just the single scattering process was found to predict the experimental scattering curve correctly in this region, and multiple scattering theory has not been developed to the point where interparticle interference effects are considered.

COR.07:025

Cornell U. [Dept. of Physics] Ithaca, N. Y.

DENSITY MEASUREMENTS OF THIN COPPER FILMS (Abstract), by N. Wainfan, M. Hommel and others. [1958] [1]p. [AF 18(600)300] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 192, May 1, 1958.

A series of "smooth" copper films, evaporated onto optically flat Pyrex substrates, was investigated. Film thickness was determined from the multiple-beam x-ray interference patterns formed on reflection near the critical angle using equations based on an ideal three media model. Mass per unit area was measured by a

chemical colorimetric method. In the range between 500 and 1100 Å, films smooth enough to exhibit the x-ray interference pattern were found to have bulk density. Present results for the above thickness range yield a density of 9.03 ± 0.36 g/cc. The values compiled by Foote and Jette for bulk copper are between 8.914 and 8.953 g/cc. Comparisons of x-ray thickness determinations with those obtained by optical interference methods are discussed.

COR.07:026

Cornell U. [Dept. of Physics] Ithaca, N. Y.

NEW TYPE OF X-RAY ENERGY LEVEL DIAGRAM (Abstract), by L. G. Parratt. [1958] [1]p. [AF 18(600)-300] Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 263, June 19, 1958.

Each level in the conventional diagram is based on a theoretical ionization state, i.e., a state in which the inner electron has been ejected to "infinity" and all the remaining electrons in the system have assumed adjusted but unique positions. In application, this diagram is confusing on several counts: (1) "infinity" is not a practical reference position, especially in a solid, (2) the ejected electron may remain bound, albeit lightly, to the positive hole it left behind, giving rise to an excitation state (or exciton), and (3) the other electrons in the system may not assume unique positions for a given inner vacancy. The confusion is greatest in solid-state spectroscopy. Some attempts have been made to include the excitation states in the diagram, but then the indicated energy differences are not correct for actual transitions. A new type of diagram, qualitative at the present state of our knowledge, is proposed in which there are many different energy states associated with each inner electron vacancy.

COR.07:027

Cornell U. [Dept. of Physics] Ithaca, N. Y.

RESOLVING POWER CORRECTION IN PRECISION MEASUREMENTS OF COMPLEX STRUCTURE (Abstract), by J. O. Porteus and L. G. Parratt. [1958] [1]p. [AF 18-(600)300; continued by AF 49(638)403] Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 263, June 19, 1958.

An observed spectral curve is always the convolution of the true curve and a resolving power smearing function.

COR.08:007 - COR.08:010

In case the resolving power smear is rather large (e.g., width of the spectral window larger than the width of a component in the true curve), it is imperative that the correction procedure be such as to minimize the final uncertainty in each true-curve point. Uncertainties arise because of experimental errors and finite interval spacings in the observed curve and in the smearing function. An optimum correction method is discussed and applied to the case of the x-ray chlorine K absorption spectra in crystalline KCl as an example in which two resolving power functions are treated successively, i.e., instrumental resolving power and then the smearing by the x-ray K-state, to arrive at a density-of-states curve of the solid. The method, practical if a digital computer is available, is sufficiently general that it may be applied to many other experimental problems requiring an optimum solution of the convolution integral.

COR.08:007

Cornell U. Dept. of Physics, Ithaca, N. Y.

STUDIES ON THE SEPARABILITY OF SIZE EFFECTS IN ELECTRON DIFFRACTION FROM SINGLE CRYSTAL SURFACES, by H. P. Furth, J. A. Krumhansl, and B. M. Siegel. Apr. 1, 1958 [21]p. incl. illus. diagrs. refs. (Technical rept. no. 7) (AFOSR-TN-58-284) (AF 18-600)674, Task 1) AD 154185 Unclassified

Reflection electron diffraction at low angles from very smooth surfaces of solids give an interface pattern which is produced by electrons scattered from only a few net planes of atoms parallel to the surface. An analysis is attempted of the information that can be obtained on the character of the diffraction phenomena from these surface net planes, conditioned by the nature of the investigations of surfaces by electron diffraction. The relaxation of the Laue conditions caused by the limited extent of the atomic arrays producing a given coherent interference will be the overriding factor in determining the type of diffraction pattern obtained from low angle electron diffraction from very smooth surfaces. The relaxation phenomena are analyzed through the use of a semi-dynamical model, which can lead to a method for investigating the possible lattice contraction of crystals in the surface planes. (Contractor's abstract)

COR.08:008

Cornell U. [Dept. of Physics] Ithaca, N. Y.

STRUCTURE OF COPPER FILMS (Abstract), by B. M. Siegel. [1958] [1]p. [AF 18(600)674, Task 1] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3 192, May 1, 1958.

The structure of thin films of copper deposited by vacuum evaporation on mica substrates has been studied utilizing a technique in which transmission electron microscopy, surface replication, and electron diffraction observations can be made on the same film. Investigations have been made on films of thicknesses from 15 to 1000A in which the deposits were made on freshly cleaved mica kept at temperatures ranging up to 450°C during deposition. When the copper is deposited on the mica at the higher temperatures there is crystallite growth which upon examination produces an interesting array of electron interference phenomena. The patterns obtained are interpreted in terms of defect structures such as stacking faults and dislocations.

COR.08:009

Cornell U. Dept. of Physics, Ithaca, N. Y.

STUDIES ON THE STRUCTURE OF EVAPORATED METAL FILMS WITH THE ELECTRON MICROSCOPE (Abstract), by B. M. Siegel. [1958] [1]p. (AF 18(600)-674, Task 1) Unclassified

Presented at meeting of the Electron Microscope Soc. Amer., Santa Monica, Calif., Aug. 7-9, 1958.

Published in Jour. Appl. Phys., v. 29: 1619, Nov. 1958.

The electron microscope has been used in a study of evaporated metal films (mainly copper), investigating with different modes of operation and methods, the structure of the deposit, the surface, the crystallite defect structure, and the mass density. Transmission electron microscopy gives important information on the defect structure of the crystal lattice which is not shown by surface examination by replication. The inelastic scattering at very low angles has been investigated as a method for determining the mass density of evaporated films and correlated with the structure observed by other methods.

COR.08:010

Cornell U. Dept. of Physics, Ithaca, N. Y.

THE ADSORPTION OF NICKEL AND ZIRCONIUM ON A CLEAN MOLYBDENUM SURFACE IN THE FIELD EMISSION MICROSCOPE, by E. C. McIlvaine and R. C. Bradley. May 1, 1957, 1v. incl. illus. diagrs. table, refs. (Technical rept. no. 5) (AFOSR-TN-57-151) (AF 18(600)-674, Task 1) AD 126440 Unclassified

An investigation of two adsorption systems, nickel on molybdenum and zirconium on molybdenum, is compared with theoretical considerations of adsorption phenomena. Nickel was found to adsorb coherently on molybdenum, preferentially on the (111) planes of the substrate. For coverages of about 1/5 of a monolayer, the following activation energies were determined:

COR.08:011 - COR.08:013

$Q_d = (2.10 \pm .05) \text{ ev}$	(desorption)
$Q_m = (1.31 \pm .08) \text{ ev}$	(surface migration 1/4 completed)
$Q_m = (1.42 \pm .05) \text{ ev}$	(surface migration 1/2 completed)
$Q_m = (1.48 \pm .06) \text{ ev}$	(surface migration 3/4 completed)

The desorption energy did not vary with degree of completion. Heavy adsorbed layers of nickel were investigated. The equilibrium position of heavy layers was found to be field-dependent. Zirconium adsorbed incoherently, in small spots on the (100) planes. Activation energies for zirconium on molybdenum were:

$Q_d = (4.10 \pm .15) \text{ ev}$	(desorption)
$Q_m = (2.90 \pm .15) \text{ ev}$	(field-free surface migration)
$Q_m = (1.36 \pm .15) \text{ ev}$	(field-enhanced surface migration).

The results of D'Asaro's molybdenum-zirconium alloy studies were reinterpreted to be indicative of purely surface phenomena. (Contractor's abstract)

COR.08:011

Cornell U. [Dept. of Physics] Ithaca, N. Y.

FIELD EMISSION MICROSCOPE STUDIES OF Zr ON Mo (Abstract), by R. C. Bradley and E. C. McIrvine. [1957] [1]p. [AF 18(600)674, Task II] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Also presented at Field Emission Symposium, Penn. State U., University Park, June 27-29, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 214, Apr. 23, 1957.

The field emission microscope has previously been used to investigate the surface conditions of an alloy of a few percent of zirconium in molybdenum. The results were interpreted on the basis of a volume diffusion process, for which an activation energy was measured. To test this interpretation, Zr was evaporated onto a Mo field-emission point and an activation energy for surface migration was measured. The agreement between measured activation energies plus the similarities in the emission patterns obtained in the two different ways suggest that in the case of the alloy the rate-controlling mechanism was also surface migration, the Zr coming from sources (presumably grain boundaries) along the shank of the point. It is thought that the initial high-

temperature flash, used primarily to clean the emitting surface of the alloy, also served to replenish these sources. Activation energies for desorption of Zr from both the alloy and the Mo surface have also been obtained and are in good agreement.

COR.08:012

Cornell U. [Dept. of Physics] Ithaca, N. Y.

SURFACE STUDY OF EVAPORATED ALUMINUM BY X-RAY TOTAL REFLECTION METHOD (Abstract), by R. C. Duncan, and L. G. Parratt. [1957] [1]p. [AF 18(600)674, Task II] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 215, Apr. 23, 1957.

Aluminum films 5000A thick, evaporated onto optically flat Pyrex glass substrates, have been studied by the x-ray total reflection method. Somewhat different rates of evaporation and different residual gas pressures were used. Five films were subjected to repeated heat treatments in atmospheric air at temperatures up to 400°C for periods up to 12 hr. Without exception they showed a marked and progressive drop in x-ray reflectivity over the entire "total" reflection region, accompanied by a very slight decrease in the critical angle and by the appearance of patches of blister-like spots over a large portion of the film surface. The most pronounced decrease in reflectivity occurred at small glancing angles, producing there a reflectivity minimum which grew progressively deeper with successive heatings. Similar films, aged at room temperature or oxidized by anodization, exhibited no such effects. The anodized film showed an increasing critical angle approaching that expected for the higher density oxide. Various sensitive parameters of the changing reflection curves appear to be better correlated with number of heatings than with temperature or length of heat treatment.

COR.08:013

Cornell U. [Dept. of Physics] Ithaca, N. Y.

SURFACE STUDY OF EVAPORATED COPPER BY X-RAY TOTAL REFLECTION METHOD (Abstract), by N. J. Scott and L. G. Parratt. [1957] [1]p. [AF 18(600)-674, Task II] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 215, Apr. 23, 1957.

Thin copper films (35 to 150A thick) evaporated onto

COR.08:014 - COR.08:016

glass substrates were studied. Contrary to observations with soft glass substrates, similar "fresh" copper films on Pyrex do not show a minimum near the critical angle. Films of 75, 120, and 150A on Pyrex were subjected to successive heat treatments up to 400°C in laboratory air. After treatment to about 130°C, the critical angle θ_c was observed to be greatly reduced, even well below the value predicted for Cu_2O on glass.

Then, continued heat treatments above about 200°C caused θ_c to increase slightly to an apparent saturation value. Similar treatments with 75A films on soft glass caused the minimum near the critical angle to "wash out" completely by the time θ_c reached its minimum

value. A pronounced low-angle dip, as observed for aluminum, developed at 300°C for films on soft glass substrates only and became progressively deeper with additional heat treatments. Theoretical dispersion calculations based on the simplest film model (having uniform density) predict only the qualitative shape of the reflection curve for either fresh or heat treated films.

COR.08:014

Cornell U. [Dept. of Physics] Ithaca, N. Y.

SPUTTERING OF MOLYBDENUM BY INERT GAS IONS OF LOW ENERGY (Abstract), by R. C. Bradley, R. C. Stabler, and A. Arakengy. [1957] [1]p. [AF 18(600)674, Task II] Unclassified

Presented at meeting of the Amer. Phys. Soc., Notre Dame U., South Bend, Ind., June 20-22, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 269, June 20, 1957.

A high vacuum 6-in. radius 60° sector field mass spectrometer has been used to study particles ejected from a molybdenum surface under bombardment by inert gas ions of low energy (< 1000 ev). The method is similar to one described recently by Honig, and has general applicability both for the analysis of surfaces of solids and for the study of sputtering. Despite the relatively large energy spread of the ejected particles, the seven isotopes of Mo could be clearly resolved in both the Mo and the MoO_2 peaks. An important feature of the method

is that there is inappreciable heating of the sample due to the ion bombardment; thus target temperature is left as an independent variable. Energy thresholds for sputtering were measured as a function of target temperature and are in good agreement with Wehner's "velocity-of-sound" formula. For a given ion energy, the sputtering was observed to decrease monotonically as the target temperature was increased. A surprising result was the high percentage of ejected particles which bore a positive charge.

COR.08:015

Cornell U. [Dept. of Physics] Ithaca, N. Y.

FIELD EMISSION FROM MAGNESIUM DEPOSITED ON TUNGSTEN (Abstract), by K. Scharf. [1957] [1]p. (Sponsored jointly by Wright Air Development Center and Air Force Office of Scientific Research under [AF 18-(600)674, Task II]) Unclassified

Presented at Field Emission Symposium, Penn. State U., University Park, June 27-29, 1957.

Field emission patterns have been observed from magnesium deposited on a clean tungsten point. The effective work functions, measured after annealing the point at different temperatures show changes as may be expected from the changing coverage of the point. An abrupt change of the effective work function from approximately 2.5 ev to 3.5 ev has been observed, when the magnesium has spread over the whole point. The latter value compares favorably with values measured by photoelectric methods.

COR.08:016

Cornell U. Dept. of Physics, Ithaca, N. Y.

ADSORPTION OF NICKEL ON MOLYBDENUM IN THE FIELD EMISSION MICROSCOPE, by E. C. McIrvine and R. C. Bradley. [1957] [7]p. incl. illus. diagrs. tables, refs. [AF 18(600)674, Task II] Unclassified

Presented at meeting of the Amer. Phys. Rev., Washington, D. C., Apr. 25-27, 1957.

Also presented at Field Emission Symposium, Penn. State U., University Park, June 27-29, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 215, Apr. 25, 1957.

Published in Jour. Chem. Phys., v. 27: 646-652, Sept. 1957.

The adsorption characteristics of Ni on a clean Mo surface have been investigated using a sealed-off field emission tube with provisions for evaporating Ni onto the Mo emitter. The location of adsorbate agrees with predictions based on the geometrical fit of coherently adsorbed material. Activation energies for desorption (Q_d) and surface migration (Q_m) were determined for coverages corresponding to about 0.2 of a monolayer. The experimental Q_d is the minimum value of Q_d for any region of the emitter, 2.10 ± 0.05 ev. In the surface migration case, the experimental Q_m varies according to the degree of completion of the migration processes: 1.31 ± 0.08 ev (1/4 completed), 1.42 ± 0.05 ev (1/2 completed), and 1.48 ± 0.06 ev (3/4 completed). For heavier

COR.08:017 - COR.08:020

coverages of adsorbate, built-up areas were observed which gave enhanced emission. At an elevated temperature which allowed migration, the equilibrium position of these areas changed reversibly upon application of the field. Other observations of heavy adsorbed layers are presented. (Contractor's abstract)

COR.08:017

Cornell U. Dept. of Physics, Ithaca, N. Y.

AN ULTRA-HIGH VACUUM MASS SPECTROMETER FOR THE STUDY OF THE SURFACES OF SOLIDS, by R. C. Bradley. Mar. 1, 1958, 1v. incl. illus. diagrs. tables, refs. (Technical rept. no. 6) (AFOSR-TN-58-97) (AF 18(600)674, Task II) AD 148148 Unclassified

A new ultra-high vacuum mass spectrometer for the study of the surfaces of solids is described. Surface atoms are removed either by ion bombardment or by evaporation and are mass analyzed in a 60° sector field mass spectrometer with a six-in. radius of curvature. The design, construction, and operation of the instrument and its associated apparatus are discussed in some detail. The results of certain experiments on the surfaces of the three refractory metals, molybdenum, tantalum, and platinum, are presented in order to indicate both the potentialities and the limitations of the instrument in its present form. (Contractor's abstract)

COR.08:018

Cornell U. Dept. of Physics, Ithaca, N. Y.

SECONDARY POSITIVE ION EMISSION FROM METAL SURFACES, by R. C. Bradley. Sept. 1, 1958 [32]p. incl. diagrs. refs. (Technical rept. no. 8) (AFOSR-TN-58-642) (AF 18(600)874, Task II) AD 162174; PB 138503 Unclassified

Also published in Jour. Appl. Phys., v. 30: 1-8, Jan. 1959.

Secondary positive ions ejected from surfaces of Mo, Ta, and Pt under bombardment by inert gas ions of low energy (< 1000 ev) were studied in high vacuum ($< 10^{-8}$ mm of Hg of background gases) using a 60° sector field mass spectrometer with a 6-in. radius of curvature, the object being to explore this as a technique for investigating solid surfaces in general. Ion species characteristic of the base metal, of surface compounds, and of a few bulk impurities were found. Quantitative analyses based on abundance ratios of the ions are unreliable owing to the enormous and essentially unknown differences in ionization efficiencies for the various species. Application of the technique to the investigation of surface kinetics seems highly promising, and as an illustration certain observations on the formation of PtO_3 on a Pt surface and its desorption at high temperatures

are presented. Another possible application is to the study of sputtering, although some of the properties of secondary ions are shown to be quite different from those of sputtered particles in general. The secondary ions characteristic of the base metal comprise only a small fraction (0.1% for Pt) of the total sputtering yield, are principally singly charged and monatomic, have a low average energy (4 to 5 ev) and energy spread, and may result either from physical sputtering of the base metal or from the dissociation of surface compounds or both. (Contractor's abstract)

COR.08:019

Cornell U. [Dept. of Physics] Ithaca, N. Y.

MASS SPECTROMETRIC STUDIES OF PARTICLES SPUTTERED FROM TANTALUM AND PLATINUM SURFACES (Abstract), by A. Arakengy and R. C. Bradley. [1958] [1]p. [AF 18(600)674, Task II] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 193, May 1, 1958.

A mass spectrometric study of secondary ions sputtered from a Mo surface in high vacuum has previously been reported by Bradley, Stabler, and Arakengy. This work has now been extended to a study of Ta and Pt surfaces. The secondary ion yield as a function of surface temperature is quite different for the three metals: it increases with increasing temperature for Pt⁺, decreases for Mo⁺, and shows a marked hysteresis effect for Ta⁺. For the Pt surface, (the only case where neutral sputtered particles were also studied) it is estimated that secondary ions comprise about 0.1% to 1% of the total yield of sputtered particles. Thermionic and secondary emission of positive ions of alkali metal impurities in the Pt have also been investigated and have led to a determination of the following activation energies: for desorption of the Na from the surface, 1.9 ± 0.1 ev; for bulk diffusion of Na, 4.7 ± 0.1 ev; for bulk diffusion of K, 4.4 ± 0.1 ev.

COR.08:020

Cornell U. [Dept. of Physics] Ithaca, N. Y.

TRANSMISSION SPUTTERING IN THIN METAL FOILS (Abstract), by R. C. Bradley. [1958] [1]p. [AF 18(600)-674, Task II] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 193, May 1, 1958.

The discovery of G. K. Wehner that sputtered particles

COR. 18:021; COR. 17:001, 002;
COR. 12:006

are ejected preferentially along the directions of close packing of metal crystals suggests the possibility that during ion bombardment energy might be propagated a considerable distance into a crystal along these same-close packed directions, and might in fact lead to the ejection of atoms from the back side of thin metal foils. Study has been made of this effect for 0.0002 in. foils of gold and aluminum under bombardment by inert gas ions of 800 ev energy. For the gold foils the results indicate that approximately one gold atom was ejected

from the back face for every 10^3 - 10^4 ions incident on the front face, that 0.1% of these were positively charged, that their energy was low (< 4 ev), and that the total yield was greatest for bombardment by Xe ions, less for A ions, still less for He ions, and undetected for bombardment by electrons of the same energy. For the aluminum foils, no transmission sputtering was detected and hence must have been less than 1 ejected Al atom for 10^8 incident ions.

COR.08:021

Cornell U. [Dept. of Physics] Ithaca, N. Y.

SECONDARY ION EMISSION FROM METAL SURFACES (Abstract), by R. C. Bradley. [1958] [1p. [AF 18(600)-674, Task II] Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

The emission of positive ions from Mo, Ta, and Pt surfaces under bombardment by inert gas ions of moderate energy (< 1000 ev) has been studied in high vacuum using a 60° sector field mass spectrometer. These ions are characteristic of the metal itself and of its surface and bulk impurities. Qualitative surface analyses are thus possible by this technique. Quantitative surface analyses are difficult, however, owing to the large differences in surface ionization probabilities for the various species. For example, the Na^+ peak from a platinum target was comparable to the Pt^+ peak even though according to spectroscopic analysis sodium could not have been present as an impurity in the solid in an amount greater than 1 part in 10,000. These studies also give information on the sputtering process itself, in particular on the energy spread and on the state of aggregation of the ejected particles. The effect of surface temperature on secondary ion emission is interesting: The Mo^+ peak from molybdenum decreases rapidly with increasing temperature whereas the Pt^+ peak from platinum increases. Certain activated processes such as diffusion and desorption of impurities have also been studied with the instrument and some results are described. (Contractor's abstract)

COR.17:001

Cornell U. Dept. of Physics, Ithaca, N. Y.

ULTRA-SMALL-ANGLE X-RAY SCATTERING, by L. G. Parratt, J. O. Porteus and others. Dec. 20, 1958 [15p. incl. diagrs. table, refs. (Technical rept. no. 2) (AFOSR-TN-58-781) (AF 49(638)402; continuation of AF 18(600)300) AD 202002; PB 137936 Unclassified

Discussion is given of the extension of the conventional small-angle scattering techniques to angles in the range of a few seconds of arc. The magnitudes of the scattered intensity in this range are large. A new double two-crystal spectrometer is proposed for this work. It is believed that with this instrument, with a high-energy synchrotron as an x-ray source, with either perfect crystals on the spectrometer for the ultra-small angles or with deliberately imperfect crystals for the conventional angular range, and with the newly developed unfolding procedures to correct for the residual instrumental effects, the techniques of small-angle scattering would be advanced to new levels of usefulness in many problems of structural analysis. Interpretive theory, now undeveloped in the ultra-small-angular range and in some respects also in the conventional angular range, would probably not lag far behind.

COR.17:002

Cornell U. Dept. of Physics, Ithaca, N. Y.

DENSITY MEASUREMENTS OF SOME THIN COPPER FILMS, by N. Wainfan, N. J. Scott, and L. G. Parratt. Dec. 1, 1958 [20p. incl. illus. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TN-58-1024) (AF 49(638)402) AD 162289; PB 138511 Unclassified

Also published in Jour. Appl. Phys., v. 30: 1604-1609, Oct. 1959.

Chemical, optical and x-ray methods have been used to determine the density of vacuum deposited layers of copper on pyrex substrates. A method of glancing angle of incidence has been used with 1.54A x-rays to find that samples which are larger than 120A have densities which equal bulk density. Differences between results found by the x-ray and optical interference methods are discussed.

COR.12:006

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

LAMINAR BOUNDARY LAYER ON A SPINNING CIRCULAR CONE IN SUPERSONIC FLOW AT A SMALL ANGLE OF ATTACK, PART II, by M. Fiebig. Feb. 1957, 14p. incl. illus. (AFOSR-TN-57-68) (AF 18(600)1523) AD 120410 Unclassified

COR.12:007 - COR.12:010

Laminar boundary layer calculations are made, mass flow defects are characterized, and displacement surface due to the boundary layer is determined, starting from previously derived results for a similar spinning cone. Additional forces due to the asymmetry of the displacement surface are calculated by means of slender-body theory.

COR.12:007

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

THE LAMINAR BOUNDARY-LAYER FLOW ON ROTATING CYLINDERS. PART I. FLAT PLATE, by S.-W. Liu. June 1957, 1v. incl. illus. tables, refs. (AFOSR-TN-57-298, pt. 1) (AF 18(600)1523) AD 132369

Unclassified

The boundary-layer equations for a cylindrical blade rotating with a constant angular speed about an axis perpendicular to the cylindrical axis are re-examined, and from the existing solutions for rotating blades an extension is made to allow the axis of rotation to be arbitrarily located with respect to the leading edge of the blade. The present report is limited to the case of a flat plate with the axis of rotation perpendicular to the plane of the plate. Two parameters are used to construct the boundary-layer flow at various locations on the plate with respect to the location of the axis of rotation. A perturbation procedure is set up by expressing the velocity components in series expansions of the parameters. Successive orders in the velocity components are obtained by numerical integration. The results show that the development of the boundary layer from the leading edge, as indicated by the relative deviation of any particular streamline from the potential streamline, is apparently unaffected by the location of the axis of rotation. Comparison with earlier first-order calculations is limited to cases where there is no eccentricity of the axis of rotation. Such first-order results are shown to give good approximations in regions where chordwise distance is much less than spanwise distance ($\frac{x}{y} \ll 1$). The streamlines of the boundary layer so calculated have smaller curvature than the more exact solutions which include higher-order terms.

COR.12:008

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

THE LAMINAR BOUNDARY-LAYER FLOW ON ROTATING CYLINDERS. PART II. THIN CYLINDERS, by S.-W. Liu. June 1957, 1v. incl. illus. tables. (AFOSR-TN-57-298, pt. 2) (AF 18(600)1523) AD 210156; PB 145479

Unclassified

The boundary-layer equations for a cylindrical blade of small thickness rotating with a constant angular speed

about an axis perpendicular to the cylindrical axis are re-examined, and from the existing solutions, an extension is made to allow the axis of rotation to be located arbitrarily with respect to the leading edge of the blade. The cylindrical symmetry is represented by assuming a universal velocity polynomial in terms of the chordwise coordinate for the chordwise potential flow. As in the flat-plate case, solution is obtained by means of series expansions in terms of appropriate parameters. In the present case, series expansion is also made in terms of the chordwise coordinate. The perturbation due to small local taper of the cylinder is also included. The deviations of the results from infinite-cylinder flow are found to be caused mainly by the modification of the outstanding pressure-gradient terms. Such effects on the chordwise flow can be favorable or adverse, depending on the location of the axis of rotation. For example, when the axis is well behind the leading edge, the pressure gradient may become so unfavorable as to cause reversal of the chordwise flow component very near the leading edge; this is interpreted to mean leading-edge separation. The correction due to taper is again found to be small. (Contractor's abstract)

COR.12:009

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

THE INTERACTION OF A REFLECTED SHOCK WAVE WITH THE BOUNDARY LAYER IN A SHOCK TUBE, by H. Mark. June 1957, 149p. illus. tables, refs. (AFOSR-TN-57-345) (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under AF 18(600)1523) AD 132418

Unclassified

Condensed version published in Jour. Aeronaut. Sciences, v. 24: 304-305, Apr. 1957.

Analysis in which simplifying assumptions are made for the interaction of the shock reflected from the closed end of a shock tube with the boundary layer of the initial shock after-flow. It is predicted that interactions of several different types will exist in different ranges of initial shock Mach number, and it is shown that the cooling effect of the wall on the after-flow boundary layer accounts for the change in interaction type. An experiment verifies the existence of several interaction regions and shows that they are satisfactorily predicted by theory.

COR.12:010

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

UNSTEADY FLOW INCLUDING SHOCK WAVES AROUND A SLENDER TWO-DIMENSIONAL BODY MOVING AT HIGH SUPERSONIC SPEEDS, by G. R. Russell. Sept. 1957 [39]p. incl. illus. refs. (AFOSR-TN-57-759) (AF 18(600)1523) AD 136748

Unclassified

COR.12:014 - COR.12:017

potential, an integral equation for the required source distribution in the upwash region is derived. Without having to solve this equation, it is shown that the potential for a point in the tip region can be obtained in terms of an integration of known source distributions over the blade surface only. The case of a twisted flat plate of particular planform is treated, and a sample calculation is made of the pressure distribution over the blade's tip region. (Contractor's abstract)

COR.12:014

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

THEORY OF THIN AIRFOILS IN FLUIDS OF HIGH ELECTRICAL CONDUCTIVITY, by W. R. Sears and E. L. Resler, Jr. Aug. 1958 [38]p. incl. diagrs. (AFOSR-TN-58-973) (AF 18(600)1523) AD 205599

Unclassified

Also published in Jour. Fluid Mech., v. 5: 257-273, Feb. 1959.

Steady, plane flow of incompressible fluid past thin cylindrical obstacles is treated, with two different orientations of the undisturbed, uniform magnetic field; viz., parallel and perpendicular, respectively, to the undisturbed, uniform stream. In the first case, the flow of an infinitely conducting fluid is shown to be irrotational and current-free except for surface currents at the walls of the obstacles. With large but infinite conductivity the surface currents are replaced by thin boundary layers of large current density. In the second case, for infinite conductivity the flow field is made up of an irrotational current-free part and a system of waves involving currents and vorticity extending out from the body. For large, finite conductivity these waves attenuate exponentially with distance from the body. In both cases the forces on sinusoidal walls and on airfoils are calculated. (Contractor's abstract)

COR.12:015

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

REMARKS ON ROCKET AND AERODYNAMIC APPLICATION OF MAGNETOHYDRODYNAMICS CHANNEL FLOW, by T. A. Wilson. Dec. 1958, 55p. incl. diagrs. (AFOSR-TN-58-1068) (AF 18(600)1523) AD 207228

Unclassified

Equations of magnetohydrodynamic channel flow are developed and the results are applied to rocket propulsion with unlimited energy supply. Two rocket configurations are described in which the energy is limited to the energy supplied by the fuel of the rocket. Rocket payload energy is increased for a given rocket fuel energy by redistributing this energy; magnetohydro-

dynamics is a feasible way to accomplish the redistribution. Descriptions are presented of a magnetohydrodynamic generator, 2 magnetohydrodynamic devices of aerodynamic interest, a hypersonic wind tunnel, and a diffuser.

COR.12:016

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

A NUMERICAL METHOD FOR SOLVING BOUNDARY-LAYER EQUATIONS, by S.-W. Liu. [1958] [2]p. [AF 18(600)1523] Unclassified

Published in Jour. Aero/Space Sciences, v. 25: 598-599, Sept. 1958.

In this paper, a method is outlined which has been used with considerable success in obtaining numerical solutions to equations commonly encountered in boundary-layer problems, and which is particularly adaptable to the high-speed computers currently in use. One advantage of this method is that the formulas used are simple and direct, with minimum of arbitrariness.

COR.12:017

Cornell U. [Graduate School of Aeronautical Engineering] Ithaca, N. Y.

A THREE-DIMENSIONAL THEORY OF AXIAL COMPRESSOR BLADE ROWS - APPLICATION IN SUBSONIC AND SUPERSONIC FLOWS, by J. E. McCune. [1958] [17]p. incl. diagrs. tables, refs. [AF 18(600)1523] Unclassified

Presented at the Twenty-Sixth Annual meeting, IAS, New York, Jan. 27-30, 1958.

Published in Jour. Aero/Space Sciences, v. 25: 544-560, Sept. 1958.

A small-perturbation theory for the description of the steady-state flow fields of axial compressor blade rows is developed by superposition of cylindrical wave functions. The relation between the full three-dimensional solution and the usual strip-theory (cascade) approximation for blade rows having a large number of blades is determined, and a similarity law for three-dimensional correction effects is provided. Numerical data necessary for the application of the general solution to configurations of arbitrary hub ratio and large blade number are presented, and this information is used in computing numerical examples in subsonic and supersonic cases. (Contractor's abstract)

COR. 12:018

Cornell U. [Graduate School of Aeronautical Engineering]
Ithaca, N. Y.

THE TRANSONIC FLOW FIELD OF AN AXIAL COMPRESSOR BLADE ROW, by J. E. McCune. [1958] [11]p. Incl. diagrs. refs. [AF 18(600)1523] Unclassified

Presented at the Twenty-Sixth annual meeting, IAS, New York, Jan. 27-30, 1958.

Published in Jour. Aero/Space Sciences, v. 25: 616-626, Oct. 1958.

The general three-dimensional theory for compressible flow through axial compressor blade rows is applied to transonic cases. Because of the occurrence in the transonic range of acoustic resonance, the theory is modified to include first-order viscous and heat-conduction effects. This approach is adequate to bring most transonic compressor problems within the realm of linear treatment. Numerical examples of the behavior of a transonic blade row are presented and discussed. The results indicate a smooth transition from the subsonic to the transonic, or mixed-flow, regimes—i.e., the degeneracy encountered in two-dimensional transonic applications of the small-perturbation theory is completely absent. At the same time, the results emphasize the failure of any strip theory, or "blade-element," approximation in the transonic range and thereby cast serious doubt upon the usefulness of transonic cascade studies. (Contractor's abstract)

COR. 13:013

Cornell U. [Sibley School of Mechanical Engineering]
Ithaca, N. Y.

NON-PARAMETRIC MULTIPLE-DECISION PROCEDURES FOR SELECTING THAT ONE OF K POPULATIONS WHICH HAS THE HIGHEST PROBABILITY OF YIELDING THE LARGEST OBSERVATION, by R. E. Bechhofer and M. Sobel. Preliminary rept. Oct. 1957, 1p. (Rept. no. 11) (AFOSR-TN-57-604) (AF 18(600)331) AD 136593 Unclassified

Presented at meeting of Inst. of Math. Stat., Los Angeles, Calif., Dec. 27-28, 1957.

Abstract published in Ann. Math. Statistics, v. 29: 325, Mar. 1958.

Let X_i be chance variables with a density function $f_i(x)$, and $p_i = \text{Prob}\{X_i > \max_{j \neq i} X_j\}$, ($i = 1, \dots, k$); then $\sum_{i=1}^k p_i = 1$. Let $p_{[1]} \geq \dots \geq p_{[k]}$ be the ranked p_i ; let θ^* , $P^* (1 \leq \theta^* \leq 1, k \geq P^* \leq 1)$ be specified constants:

select the population associated with $p_{[k]}$ by a procedure which guarantees the requirement, $\text{Prob}\{\text{correct selection} | p_{[k]} \geq \theta^* p_{[k-1]}\} \geq P^*$. At the m^{th} stage of experimentation take the vector observation $\bar{x}_m = (x_m, \dots, x_{km})$ where the x_{ij} ($j = 1, 2, \dots$) are independent observations from the i^{th} population. Consider the vector $\bar{y}_m = (y_{1m}, \dots, y_{km})$ which is obtained by replacing the largest component of \bar{x}_m by unity, and all other components by zero; then \bar{y}_m is an observation from a multinomial distribution with probability p_i associated with the i^{th} component ($i = 1, 2, \dots, k$). The requirement is guaranteed with procedures previously proposed (Ann. Math. Statistics, v. 27: 861). If $f_i(x) = g\left(\frac{x-\mu_i}{\sigma}\right)$, ($i = 1, 2, \dots, k$), then the procedure can be used to select the population associated with the largest μ_i for any θ , known or unknown.

Similar non-parametric multiple-decision procedures in which pairs of observations are taken from each population at each stage of experimentation, and which employ the range of each pair can be used for selecting that one of k populations which has the highest probability of yielding the largest sample range. If $f_i(x) =$

$\frac{x-\mu_i}{\sigma}$, ($i = 1, 2, \dots, k$) then these latter procedures can be

used for selecting the population associated with the largest θ_i for any set of μ_i , known or unknown. (Contractor's abstract)

COR. 13:014

Cornell U. Sibley School of Mechanical Engineering,
Ithaca, N. Y.

A SINGLE-SAMPLE MULTIPLE-DECISION PROCEDURE FOR SELECTING THE MULTINOMIAL EVENT WHICH HAS THE HIGHEST PROBABILITY, by R. E. Bechhofer, S. Elmaghraby, and N. Morse. Dec. 1957, 26p. Incl. tables. (Mechanical engineering rept. no. 12) (AFOSR-TN-57-710) (AF 18(600)331) AD 136704 Unclassified

Also published in Ann. Math. Statistics, v. 30: 102-119, Mar. 1959.

The problem of selecting the multinomial event with the highest probability is formulated as a multiple-decision selection problem. Taking θ as the true ratio and P as the true probability of a correct selection, θ^* is the smallest value of θ worth detecting and P^* is the smallest acceptable value of P when $\theta \geq \theta^*$. A single-sample procedure is proposed which guarantees that $P \geq P^*$ whenever the true, but unknown, ratio of the largest to the second largest of the population probabilities is equal to or greater than θ^* . The basis of the procedure is the proper choice of N , the number of trials.

COR.13:015-017; CWC.01:001

Two methods of determining N_{max} described. The first is exact and is to be used when N is small; the second is approximate for cases when N is large. Tables and sample calculations are included.

COR.13:015

Cornell U. Sibley School of Mechanical Engineering, Ithaca, N. Y.

MULTIPLE DECISION PROCEDURES FOR SELECTING THAT MULTINOMIAL EVENT WHICH HAS THE LARGEST PROBABILITY, by S. Elmaghraby and N. Morse. [1957] 16p. incl. tables. (AF 18(600)331) AD 154164
Unclassified

Presented at annual meeting of the Inst. of Math. Statistics, Atlantic City, N. J., Sept. 10, 1957.

A single-sample procedure and a sequential procedure are given that will satisfy the requirement that the probability of selecting the correct event is equal to or greater than some smallest acceptable probability when the ratio of the largest to the second largest population probabilities is larger than some fixed number. An example is calculated of the number of observations necessary in order to predict with 90% certainty which of the numbers on an unbalanced roulette wheel should be selected if it is known that the probability of occurrence of one number is at least 10% larger than the next most probable number.

COR.13:016

Cornell U. [Sibley School of Mechanical Engineering] Ithaca, N. Y.

A PROPERTY OF THE MULTINOMIAL DISTRIBUTION, by H. Kesten and N. Morse. Feb. 1958, 12p. (AFOSR-TN-58-92) (AF 18(600)331) AD 148142
Unclassified

Also published in Ann. Math. Statistics, v. 30: 120-127, Mar. 1959.

A property of the multinomial distribution is proved which is fundamental to the choice of sample size for the selection procedure described in the paper by Bechhofer, Elmaghraby, and Morse, A single-sample multiple-decision procedure for selecting the multinomial event which has the highest probability (item no. COR.13:014). Proof is given for the theorem of least favorable configurations. This theorem assembles the results of preceding lemmas. The main ideas of the result are contained in 2 lemmas which are proved by imposing certain conditions to permit reduction of the probability of a correction selection.

COR.13:017

Cornell U. Sibley School of Mechanical Engineering, Ithaca, N. Y.

SEQUENTIAL MULTIPLE-DECISION PROCEDURES FOR RANKING PARAMETERS OF KOOPMAN-DARMOIS POPULATIONS WITH SPECIAL REFERENCE TO RANKING MEANS OF NORMAL POPULATIONS, by R. E. Bechhofer and M. Sobel. Mar. 17, 1958 [188]p. incl. tables. (AFOSR-TN-58-260) (AF 18(600)331) AD 154164
Unclassified

The general theory for the procedures is developed where it is assumed the frequency functions associated with the k populations all have the same known form and differ at most in the value of a single parameter τ . One population is better than another when it has a larger τ -value. The correct pairing of the ordered τ -values with the populations is unknown, as are the τ -values themselves. Six forms of Koopman-Darmois populations including normal populations with unknown means and a common known variance, and binomial populations with unknown probabilities of "success" are treated in detail, in part I. Part II contains special theoretical results for two populations. Part III describes experimental samplings and the results obtained which were conducted to simulate (by Monte Carlo methods) the application of the basic procedure (and several of the other proposed procedures) to the selection of the T best populations without regard to order for Koopman-Darmois normal populations with unknown means and a common variance. Part IV contains a statement of some of the more important unsolved problems, and an indication of the directions future research may take.

Cruft Lab., Cambridge, Mass.

see Harvard U. Cruft Lab., Cambridge, Mass.

CWC.01:001

Curtiss Wright Corp. Aerophysics Development Div., Santa Barbara, Calif.

NON-STATIONARY COMBUSTION STUDIES, by D. Bitondo, N. Thomas, and D. Perper. Sept. 1957, 42p. incl. illus. diagrs. (AFOSR-TN-57-454) (AF 18(600)-1509) AD 136444
Unclassified

Also published in Proc. Heat Transfer and Fluid Mech. Inst., Calif. Inst. of Tech., Pasadena (June 19-21, 1957) Stanford, Stanford U. Press, 1957, p. 343-358. (Title varies)

A study of gaseous fuel ignition in transient flow by means of a "heated wall" mounted in the test section of a shock tube is the subject of this report. The process was followed photographically by means of schlieren apparatus and a spark-gap light source timed by means of electronic time-delay equipment. The results established

CWC.01:002

the existence of an ignition delay time considerably longer than in steady flow, due to boundary layer effects. The dependence of this delay time on various physical parameters has been studied. (Contractor's abstract)

CWC.01:002

Curtiss Wright Corp. Aerophysics Development Div.,
Santa Barbara, Calif.

NON-STATIONARY COMBUSTION STUDIES, by D.
Bitondo and D. Perper. Aug. 1958, 50p. incl. illus.
diags. refs. (Technical rept. no. 58-98) (AFOSR-TR-
58-144) (AF 18(600)1509) AD 204734 Unclassified

A study of gaseous fuel ignition in transient flow by

means of a "heated wall" mounted in the test section of a shock tube is the subject of this report. The process was followed photographically by means of schlieren apparatus and a high speed Fastax movie camera. Pressure in the test section and in the immediate vicinity was followed by means of high frequency pressure recorders. The results establish the existence of an ignition time delay considerably longer than in steady flow and indicate a marked dependence of ignition time delay on surface roughness and turbulence level in the air stream. Pressure pulses produced by combustion are always greater than those produced if the flow was completely blocked and are further strengthened as they travel upstream. The dependence of the ignition delay time and to some extent the dependence of the peak of the pressure pulse on various physical parameters has been studied.



AIR FORCE SCIENTIFIC RESEARCH

DTM.01:001; DEL.02:001;
DEL.01:006, 007; DET.01:003

David Sarnoff Research Center, Princeton, N. J.
see Radio Corp. of America. David Sarnoff Research
Center, Princeton, N. J.

DTM.01:001

David Taylor Model Basin, Washington, D. C.

SKIN FRICTION EXPERIMENTS ON FLAT PLATES
WITH NIKURADSE COATINGS, by W. B. Hinlerthan.
Aug. 1957, 53p. incl. illus. diagrs. tables. (Report no.
1159) (AFOSR-TN-58-1137) (NS-715-102)

Restricted data

Defense Research Lab., Austin, Tex.
see Texas U. Defense Research Lab., Austin.

DEL.02:001

Delaware U. Dept. of Chemical Engineering, Newark.

TURBULENCE IN NON-NEWTONIAN SYSTEMS, by D.
W. Dodge and A. B. Metzner. Feb. 1958, 75p. incl.
diagrs. refs. (AFOSR-TN-58-94) (AF 18(603)115)
AD 148143

Unclassified

A theoretical analysis for turbulent flow of non-Newtonian fluids through smooth round tubes has been performed for the first time, and has yielded a completely new concept of the attending relationship between the pressure loss and mean flowrate. In addition, the analysis has permitted the prediction of non-Newtonian turbulent velocity profiles, a topic about which the published literature is entirely void. To confirm the theoretical analysis, experimental data were taken both on polymeric gels and solid-liquid suspensions under turbulent flow conditions. Fluid systems with flow-behavior indexes between 0.3 and 1.0 were studied at Reynolds numbers as high as 36,000. All of the fully turbulent experimental data supported the validity of the theoretical analysis. The final resistance law correlation represents a generalization of von Karman's equation for Newtonian fluids in turbulent flow, and is applicable to all non-Newtonians for which the shear rate depends only on shear stress, irrespective of their rheological classification. All the turbulent experimental data were for the non-Newtonian systems correlated by this relationship with a mean deviation of 1.9 percent. Some polymeric gels are shown to deviate from the above relationship, possibly due to elasticity effects. (Contractor's abstract)

DEL.01:006

Delaware U. Dept. of Physics, Newark.

EVALUATION OF MOLECULAR QUADRUPOLE
MOMENTS FROM MICROWAVE SPECTRAL LINE

BREADTHS. II. EXPERIMENTAL, by H. Feeny, W. Madigosky, and B. Winters. June 6, 1957 [15]p. incl. diagrs. tables. (Rept. no. 5) (AFOSR-TN-57-299) AD 18(600)449 AD 132370

Unclassified

Also published in Jour. Chem. Phys., v. 27: 898-900, Oct. 1957.

An improved microwave spectroscopy has been used to determine the effect of O_2 , N_2 , CO_2 , and H_2 in broadening the $J = 3 - 3$ inversion line of ammonia. An accurate evaluation of the molecular quadrupole moments of these gases was obtained from the measured collision diameters of 4.32, 6.33, 7.45, and 3.28 angstrom units, respectively.

DEL.01:007

Delaware U. Dept. of Physics, Newark.

PLANARITY OF THE FORMIC ACID MONOMER, by R. Trambarulo, A. Clark, and C. Hearns. Sept. 30, 1957, 4p. diagrs. tables. (Rept. no. 6) (AFOSR-TN-57-619) (AF 18(600)449) AD 136608

Unclassified

Also published in Jour. Chem. Phys., v. 28: 736-737, Apr. 1958.

Lines in the microwave spectrum of formic acid which were found between 8.7 and 58.8 kMc have been identified. From these assignments the three principal moments of inertia were calculated, and the molecule was found to be planar.

DET.01:003

Detroit U. [Research Inst. of Science and Engineering] Mich.

MATHEMATICAL THEORY OF PLASTICITY BASED ON SLIP, by H. Payne, S. J. Czyzak, and W. Lucas. Sept. 1, 1957 [29]p. incl. diagrs. table. (AFOSR-TR-57-61) (AF 18(600)1466) AD 136545

Unclassified

Mathematical theory is developed to calculate the superposed torsional strain upon the plastic tensile strain. The method of Taylor (item no. DET.01:001) for calculating the plastic stress-strain relation in polycrystals is extended and applied to 2 problems involving face-centered cubic crystals. Work on the first problem which considered the simple tensile strain only (item no. DET.01:002) has been completed. The second problem involves a superposed incremental torsional strain upon the tensile strain in the plastic region. The derivation of the mathematical relations and the results of the preliminary calculations are presented.

DET.01:004 - DET.01:008

DET.01:004

Detroit U. [Research Inst. of Science and Engineering]
Mich.

A METHOD FOR CALCULATING THE TORSIONAL STRAIN VS STRESS ON AN ALREADY AXIALLY LOADED THIN WALLED CYLINDER, by H. Payne, S. J. Czyzak, and W. Lucas. Mar. 1, 1958 [10]p. incl. diagr. table. (AFOSR-TN-58-248) (AF 18(600)1466) AD 154151; PB 133960 Unclassified

A new method of calculating the superposed torsional strain is described. This is an extension of T. H. Lin's method for the uniaxial case. Contrary to earlier calculations it was found that a displacement in a given slip system which is opposite in sense to one previously occurring is due to plastic, as well as elastic strain.

DET.01:005

Detroit U. [Research Inst. of Science and Engineering]
Mich.

DEVELOPMENT OF A MATHEMATICAL THEORY OF PLASTICITY BASED ON THE CONCEPT OF SLIP, by H. Payne and S. J. Czyzak. Oct. 1, 1958, 41p. incl. diagr. tables. (AFOSR-TN-58-779) (AF 18(600)1466) AD 202000 Unclassified

The model developed by Taylor for calculating the stress-strain relation for a polycrystalline material following a non-linear strain path is reviewed and extended. This theory is applied to the problem of a thin wall cylinder which is subjected to an incremental torsional strain on an already existing tensile or compressional strain.

DET.01:006

Detroit U. [Research Inst. of Science and Engineering]
Mich.

AN APPLICATION OF THE SLIP METHOD OF PLASTICITY TO A NON-UNIAXIAL CASE, by W. Lucas. Jan. 1958, 30p. incl. diagr. tables, refs. (Thesis) [AF 18(600)1466] Unclassified

Lin's extension of Taylor's slip theory of plasticity is applied to a non-uniaxial case by superposing an incremental torsional strain on a plastic tensile or compressive strain. This problem is solved in detail for $\theta = 60^\circ$ and $\theta = 45^\circ$. The most important result is the elastic strain tensor in the specimen axis given in the following equation:

$$(\epsilon^e)_{ij} = \begin{bmatrix} 2145 & 0 & 0 \\ 0 & 3402 & -1172 \\ 0 & -1172 & -6747 \end{bmatrix}$$

If the tensor $(\epsilon^e)_{ij}$ is computed for the other 43 values

of θ and ρ , and the resulting tensors averaged over all the orientations, an elastic strain tensor can be obtained which represents the aggregate. From this aggregate strain tensor, a tensile and torsional stress tensor can be computed. From this aggregate stress tensor, a theoretical stress-strain relation can be obtained which can then be compared with experimental data on polycrystalline aggregates of aluminum. Such a comparison would serve as a critical test of the validity of this slip theory of plasticity.

DET.01:007

Detroit U. [Research Inst. of Science and Engineering]
Mich.

AN APPLICATION OF THE SLIP THEORY OF PLASTICITY BASED ON LIN'S EXTENSION OF TAYLOR'S METHOD TO THE NON-UNIAXIAL CASE, by P. T. Dacko. June 1958, 30p. incl. diagr. tables, refs. (Thesis) [AF 18(600)1466] Unclassified

The application of Lin's modification to Taylor's method permits a means by which the stress-strain relation in a polycrystalline solid may be determined for any stage of loading. Both Taylor's method and Lin's modification compare favorably with experiment when the loading is simple tensile or compressive loading. The purpose of this paper is the investigation of the application of Lin's modification to the more critical case of a torsional load superposed on an already existing tensile or compressive load. The mathematical method used in performing the calculations, is based on the work of Payne, Czyzak, and Lucas. Little can be said at present regarding the results of the calculations. When the calculations for all 44 orientations have been completed, a comparison between the average of these values and experimental values may be made.

DET.01:008

Detroit U. [Research Inst. of Science and Engineering]
Mich.

A MODIFICATION OF TAYLOR'S METHOD FOR CALCULATING THE PLASTIC STRESS-STRAIN RELATION IN FACE-CENTERED CUBIC CRYSTALS, by H. Payne, S. J. Czyzak and others. [1958] [7]p. incl. table. (AF 18(600)1466) Unclassified

Published in Jour. Mech. and Phys. of Solids, v. 6: 314-320, July 1958.

A method is presented for determining the stress-strain relation in the plastic region for polycrystalline materials from empirical data on slipping in the corresponding single crystal. Results of calculations for uniaxial loading are presented. (Contractor's abstract)

DOC.01:001 - DOC.01:005

DOC.01:001

Documentation, Inc., Washington, D. C.

MEANING, LINGUISTIC STRUCTURES AND STORAGE AND RETRIEVAL SYSTEMS, by M. Taube. Feb. 1957, 14p. incl. diagr. (AFOSR-TN-57-125) (AF 49(638)91) AD 120482 Unclassified

This paper attempts to establish the positive thesis that storage and retrieval theory and the design of storage and retrieval systems need not concern itself with "the relationship between concepts and the words and symbols in which they are expressed," with the attempt to base such relationships on the distinction between nominal classes and "real" classes.

DOC.01:002

Documentation, Inc., Washington, D. C.

THE DISTINCTION BETWEEN THE LOGIC OF COMPUTERS AND THE LOGIC OF STORAGE AND RETRIEVAL DEVICES, by M. Taube. Rev. ed. Sept. 1957, 12p. incl. diagr. refs. (AFOSR-TN-57-165) (AF 49(638)91) AD 126458 Unclassified

Storage and retrieval devices are differentiated from computers within the general class of automatic data handling devices. The basis for this differentiation is both negative and positive; negative in that the identity of computers and computer logic with automata and the logic of automata in general is shown to be in error; and positive in that the specific logic of storage and retrieval automata is shown to be the algebra of classes as distinct from the propositional calculus which is the logical instrument for the analysis of computers and computer circuits. As a final point, the time sequence in computer operation is shown to be analogous to non-commutative pairs in the algebra of classes.

DOC.01:003

Documentation, Inc., Washington, D. C.

THE DESCRIPTIVE CONTINUUM. A "GENERALIZED" THEORY OF INDEXING, by F. Jonker. June 1957, 26p. incl. diagr. (AFOSR-TN-57-287) (AF 49(638)91) AD 132358 Unclassified

Also published in Proc. Internat'l. Conf. on Scientific Information, Washington, D.C. (Nov. 16-21, 1958), Washington, Nat'l Acad. Sciences, v. 2: 1291-1311, 1959.

The degree of adequacy and total cost of indexing systems in mechanized information retrieval is studied in search of general criteria for the systems. The history of information control is traced from the earliest classification

systems through subject heading systems to recent developments (Uniterm indexing) in an attempt to establish a "generalized theory" of indexing. A theory of indexing looks on all systems as a "descriptive continuum" with "entry" length chosen as the main parameter. The continuum ranges from keyword indexing through subject heading indexing to hierarchic classification. Other parameters are potential depth of indexing, permutability of indexing criteria, degree of hierarchical definition of indexing, potential need for a coordinating mechanism, retrieval noise, size of the access apparatus, false coordinations and capacity for handling semantic indeterminacy. The theory indicates that with the determination of the main parameter, other system properties are fixed. For the information collection, an optimal continuum position can be related to the degree of diffuseness of the field's information.

DOC.01:004

Documentation, Inc., Washington, D. C.

MATHEMATICAL FOUNDATIONS FOR A STORAGE AND RETRIEVAL THEORY, by A. Kreithen. June 1957, 15p. (AFOSR-TN-57-400) (AF 49(638)91) AD 132475 Unclassified

Some of the fundamental concepts of a mathematical basis for a storage and retrieval theory are noted, and a terminology and notation are developed for representation by set theory. The possible ways in which a collection of information can be organized for storage and retrieval are presented, and the properties of each form of organization are outlined. The resulting effect on the theory is studied of the incorporation of certain relations between terms, such as meaning and order. The problems, which include nonmathematical as well as logical or mathematical relations, in a formal theory are discussed, and some consequences are pointed out for the storage requirements of realizable systems. The properties of specific indexing schemes are closely represented by particular mathematical systems. (Contractor's abstract)

DOC.01:005

Documentation, Inc., Washington, D. C.

A TRUTH-TABLE EVALUATION OF THE LOGIC OF NERVE NETS, by M. Taube. July 1957, 20p. incl. diagr. tables. (AFOSR-TN-57-482) (AF 49(638)91) AD 136475 Unclassified

An analysis of the basic motion of logical representation of a physical event in a computer or of a biological event in a nerve net is discussed.

DOC.01:006

Documentation, Inc., Washington, D. C.

THE RELATION OF THE SIZE OF THE QUESTION TO THE WORK ACCOMPLISHED BY A STORAGE AND RETRIEVAL SYSTEM, by M. Taube and L. B. Hellprin. Aug. 1957 [13]p. (AFOSR-TN-57-483) (AF 49(638)91) AD 136476 Unclassified

Presented at Amer. Chem. Soc., Chemical Literature Session, New York, Sept. 1957.

Definitions given by Kreithen (item no. DOC.01:004) of code element, coding field, bit, character, word, item, store, and question are extended. Work accomplished in a search is defined as the set of items in a store selected by matching the terms in the question against the terms recorded in a store to describe the items. The bearing of this concept of work on the design of storage and retrieval devices (especially the Rapid Selector and the Minicard System) is discussed. A mathematical analysis is appended in which the unit of work accomplished is defined as the matching of 1 word in the question against 1 word in the store and the unit of search power is 1 search work unit per unit time. Results indicate that (1) in any search of an information store by either sequential or parallel matching, the sequential search work is less; (2) search time saved by a parallel instead of a sequential search is proportionately less than the increase in search power required to save the time; and (3) asking an ordered question involves either more units of work or more memory capacity than asking a question in which order of terms is immaterial.

DOC.01:007

Documentation, Inc., Washington, D. C.

MATHEMATICAL MODEL OF INDEXING, by L. B. Hellprin. Aug. 1957 [24]p. incl. diagr. (AFOSR-TN-57-484) (AF 49(638)91) AD 136477 Unclassified

The main problems in storage and retrieval of an item of information are indexing, coding, and mechanization. Jonker has recently presented a theory of indexing (item no. DOC.01:003). According to the theory all indexing systems can be located on a "descriptive continuum" the parameter for which is average length of indexing terms. This paper develops a mathematical model from Jonker's theory. The descriptive continuum is mathematically equivalent to the range between complete dependence and independence of indexing terms. The main task is to find functional forms for the variables. Some new concepts are introduced: number of search paths, ideal indexing system, permutability noise, hierarchical noise. An indexing equation is derived: $RH = n_0(1-M)$ where R is retrieval power, H is degree of hierarchical classification, n is the maximum number of independent indexing terms per item, and M

is hierarchical noise. The "ideal case" in which $M = 0$ corresponds to Jonker's original concept. Suggestions are given for use of the model in indexing system design. (Contractor's abstract)

DOC.01:008

Documentation Inc., Washington, D. C.

INFORMATION STORAGE AND RETRIEVAL THEORY, SYSTEMS, AND DEVICES; AN AFOSR SYMPOSIUM, Washington, D. C. (Mar. 17-18, 1958), ed. by M. Taube and H. Wooster. New York, Columbia U. Press, 1958, 228p. incl. diagr. table, refs. (AFOSR-TN-58-190) (AF 49(638)91) AD 152236 Unclassified

This book is divided into 2 parts. Part I is an orientation to the subject matter prepared prior to the symposium. It deals with the scope, history, present state and future of information storage and retrieval. Part II is a condensation of the introductory remarks and discussions at the symposium in the following general areas: (1) the relation of storage to retrieval; (2) the relation of physical to symbolic systems; (3) the logic of retrieval devices; (4) digital coding for information retrieval; (5) the grouping and arrangement of terms, items and their codes; (6) the environment and requirements of a system; and (7) indexing, language, and meaning. A summary is included.

DOC.01:009

Documentation, Inc., Washington, D. C.

THE COMAC. AN EFFICIENT PUNCHED CARD COL-LATING SYSTEM FOR THE STORAGE AND RETRIEVAL OF INFORMATION, by M. Taube. Oct. 1957, 20p. incl. diagr. (AFOSR-TN-58-365) (AF 49(638)91) AD 154271 Unclassified

Also published in Proc. Internat'l. Conf. on Scientific Information, Washington, D. C. (Nov. 16-21, 1958), Washington, Nat'l. Acad. Sciences, v. 2: 1245-1254, 1959.

An analysis of the theory of using punched card sorters and collators for the storage and retrieval of information is given. The general logical requirements of storage and retrieval systems involving, efficient input, compact storage, rapid search and freedom from machine constraints on the intellectual operations of document analysis is also discussed. A new system of punched card devices is presented which is adequate for collections of information of any size and complexity. There is thus achieved the description of a general purpose information storage and retrieval device called the COMAC. This device can match codes on one punched card against codes on another punched card, and punch the codes for the logical product or sum on a third card. The COMAC devices should decrease search time, allow multiple access to the store, eliminate refiling, reproduce

DOC.01:010-012; DUB.01:001, 002

and print out cards, and free indexing from machine constraints. (Contractor's abstract, modified)

DOC.01:010

Documentation, Inc., Washington, D. C.

A COMPARISON OF CONVENTIONAL GROUPING AND INVERTED GROUPING OF CODES FOR THE STORAGE AND RETRIEVAL OF CHEMICAL DATA, by E. Miller, D. Ballard and others. May 1958 [23]p. incl. illus. diags. tables. (AFOSR-TN-58-366) (AF 49(638)91) AD 154272
Unclassified

Also published in Proc. Internat'l. Conf. on Scientific Information, Washington, D. C. (Nov. 16-21, 1958), Washington, Nat'l. Acad. Sciences, v. 1: 671-685, 1959. (Title varies)

Direct experimental comparison of the operation of two different information storage and retrieval systems using conventional and inverted groupings respectively has been carried out using the U. S. Patent Office punched-card index to steroid patents. Identical Patent Office index terms were used in both systems. Equal search results were thus obtainable from both systems. Comparison is made on the basis of equipment cost and operating time to put in the same material and find the same answers to a series of queries. An IBM sorter and a modified Type 101 machine were used for the conventionally grouped material, while a "Matrex" device was employed for the inverted group arrangement. The Matrex approach was somewhat more costly on input, but far more economical in both equipment cost and presentation of answers to queries. These differences are magnified as the size of the collection grows. A side result shows that the IBM sorter improves in efficiency over the Type 101 machine as the size of the collection increases. (Contractor's abstract, modified)

DOC.01:011

Documentation, Inc., Washington, D. C.

DESIGN CONSIDERATIONS OF INFORMATION STORAGE AND RETRIEVAL MACHINES, by F. Jonker. Apr. 1958 [25]p. incl. diags. (AFOSR-TN-58-367) (AF 49(638)91) AD 154273; PB 134759
Unclassified

Basic and applied parameters for the design of information storage and retrieval devices are discussed. A distinction is made between primary design considerations of a more abstract nature, and less abstract secondary considerations. The primary design considerations are used as a framework for classifying the various types of information storage and retrieval systems. This classification is a practical frame of reference to allow similarities and differences to be seen, and to apply systematic thinking to the problems of information storage and retrieval machines. It may help create some

order in the ever-growing tangle of competing systems. (Contractor's abstract)

DOC.01:012

Documentation, Inc., Washington, D. C.

AN EVALUATION OF USE STUDIES OF SCIENTIFIC INFORMATION, by M. Taube. Dec. 1958, 23p. incl. refs. (AFOSR-TN-58-1050) (AF 49(638)91) AD 206987; PB 138260
Unclassified

An evaluation of the existing literature on use studies is attempted. The conclusions drawn by other surveys of use studies which appeared before the International Conference on Scientific Information in November 1958 are accepted, and these conclusions are brought up to date by abstracting and evaluating the studies prepared for the conference. An attempt is made to analyze the reasons for the generally accepted failure of use studies by establishing a distinction between consumer services and professional services. It is concluded that the organization and dissemination of scientific information is a professional activity, the value of which cannot be measured by consumer responses, and that such responses cannot supply directions for the design of more effective scientific information and reference systems. (Contractor's abstract)

DUB.01:001

Dublin Inst. for Advanced Studies (Ireland).

DIRECTIONAL PROPERTIES OF AN EXTENSIVE AIR SHOWER ARRAY, by C. B. A. McCusker, D. E. Page, and R. J. Reid. Apr. 1958 [7]p. incl. tables. (Technical note no. 1) (AFOSR-TN-58-295) (AF 61(514)1164) AD 154204
Unclassified

Also published in Phys. Rev., v. 116: 181-182, Oct. 1, 1959.

The directional properties of an extensive air shower array consisting of three Geiger-Müller counter telescopes have been examined. It is shown that the directional properties of this array show no great improvement over more conventional arrangements. Possible ways of improving the performance of the device are suggested. (Contractor's abstract)

DUB.01:002

Dublin Inst. for Advanced Studies (Ireland).

MEASUREMENT OF PRIMARY DIRECTIONS IN EXTENSIVE AIR SHOWERS, by C. B. A. McCusker. Apr. 1958 [13]p. incl. diagr. tables. (Technical note no. 2) (AFOSR-TN-58-296) (AF 61(514)1164) AD 154205
Unclassified

DUK.02:004-008; DUK.04:001

Also published in Phys. Rev., v. 118: 177-180, Oct. 1, 1959.

The abilities of various extensive shower arrays to detect possible departures from isotropy of the directions of incidence of very high-energy cosmic-ray primaries are analyzed. The effects of angular resolution, selectivity of total energy and sensitivity to the nature of the primary are discussed. A simple method of analyzing variation in intensity with declination is given and applied to some recent experimental results. It is shown that in two well-known cases, these are not consistent with the hypothesis of isotropy of incoming directions. (Contractor's abstract)

DUK.02:005

Duke U. [Dept. of Mathematics] Durham, N. C.

AN UNUSUAL STABILITY CRITERION FOR A DIFFERENCE ANALOGUE OF THE HEAT EQUATION, by J. Douglas, Jr. Aug. 1958, 7p. (AFOSR-TN-58-787) (AF 18(800)1341) AD 201922; PB 138178 Unclassified

Also published in Jour. Math. Phys., v. 38: 150-152, July 1959.

Frequently in the numerical solution of the heat equation by a difference equation, it is necessary to impose a restriction between the time increment Δt and the space increment Δx of the form

$$0 < \frac{\Delta t}{(\Delta x)^2} \leq k < \infty. \text{ In attempting to obtain a high order}$$

correct difference analogue of the heat equation in two space variables, several difference equations are developed for which it is necessary that

$$0 < k \leq \frac{\Delta t}{(\Delta x)^2} < \infty \text{ for stability and convergence. (Contractor's abstract)}$$

DUK.02:006

Duke U. Dept. of Mathematics, Durham, N. C.

AN APPROXIMATE SOLUTION OF AN IMPROPER BOUNDARY VALUE PROBLEM, by J. Douglas, Jr. and T. M. Gallie, Jr. Aug. 1958, 18p. incl. refs. (In cooperation with Rice Inst., Houston, Tex.) (AFOSR-TN-58-776) (AF 18(800)1341) AD 201624; PB 138174 Unclassified

Also published in Duke Math. Jour., v. 26: 339-347, Sept. 1959.

A new solution of an improperly posed problem is presented on smoothed solutions of an integral equation. The method is to seek a normal family of solutions of the corresponding differential equation. A normal family need not be smooth and a family of smooth functions need not be normal. Numerical experiments indicated that this method gives a considerably better approximation to the true solution. (Contractor's abstract)

DUK.04:001

Duke U. [Dept. of Mathematics] Durham, N. C.

MACHINE CALCULATION OF MATHEMATICAL FUNCTIONS, by S. G. Campbell. Sept. 1957, 17p. (AFOSR-TN-57-583) (AF 18(600)1539) AD 136571 Unclassified

DUK.02:004

Duke U. [Dept. of Mathematics] Durham, N. C.

ON THE ZEROS OF THE DERIVATIVES OF SOME ENTIRE FUNCTIONS, by R. M. McLeod. June 1957, 25p. refs. (AFOSR-TN-57-353) (AF 18(800)1341) AD 132426 Unclassified

Also published in Trans. Amer. Math. Soc., v. 91: 354-367, May 1959.

Let f be an entire function. Let $\{L_k\}$ be a set of points z such that to each disk D centered at z , there corresponds a sequence of integers $\{n_k\}$ and a sequence of points $\{z_k\}$, $z_k \in D$, such that $f^{(n_k)}(z_k) = 0$. Polya (Math. Zeitschr., v. 12: 38-60, 1922) determined $\{L_k\}$ for functions of f of finite order greater than or equal to 2 with only a finite set of zeros; these results are extended by relaxing the restriction on the set of zeros of f . Let $f(z) = \phi(z) \exp(cz^q + dz^{q-1})$, $q \geq 2$, where $M(\log|\phi|, 0, r) = o(r^{q-1})$, and let $\{R_k\}$ be the set made up of the q rays emanating from the point $-d/(qc)$ and passing through $-d/(qc) + \alpha_k(c) e^{i\pi/q}$, $k = 0, 1, \dots, q-1$. Polya proved that $\{L_k\} = \{R_k\}$ if f has a finite set of zeros; by application of his result to functions approximating to an f with an infinite set of zeros, it is found that zeros of f influence $\{L_k\}$ only in the directions $\alpha_k(c)$; for f of the classes $\{F\}$ and $\{G\}$ again $\{L_k\} = \{R_k\}$. The proof is a simplified version of Polya's procedure: (1) the asymptotic behavior of $f^{(n)}(z)$ in certain sectors is found by a modification of a generalization of Stirling's formula due to Hayman (Jour. Reine Angew. Math., v. 196: 69, 1956); and (2) a theorem of Ganelius (Ark. Matem., v. 3: 33, 1954) is applied which gives an estimate from below on the number of zeros in certain neighborhoods. (ASTIA abstract)

DUK.04:002 - DUK.04:006

A discussion is presented of the numerical calculation of mathematical functions. The calculation of elementary functions is discussed with certain conclusions drawn as the result of considerable theoretical study and extensive experimentation on the Oracle computer. Generally speaking the most usual method is the evaluation of truncated power series because they are easy to produce, their theory is simple, and they have no extreme properties, being neither fast nor slow; they are simple to code and offer simple problems in error analysis. Continued fractions, on the other hand present difficult problems in error analysis and programming. The most commonly used techniques are discussed. These fall into the analytical methods which include the truncated series expansions, expansion in orthogonal functions, addition formulas, and analytic continuation; and the numerical methods which include interpolation from tabulated values, successive approximation, numerical quadrature, numerical integration of differential equations, and Monte Carlo techniques.

DUK.04:002

Duke U. [Dept. of Mathematics] Durham, N. C.

NUMERICAL MATHEMATICS AND COMPUTING MECHANISMS, by S. G. Campbell. Sept. 1957 [63]p. incl. tables. (AFOSR-TN-57-584) (AF 18(600)1539) AD 136572 Unclassified

Numerical mathematics is defined. The historical background, present status, and future development of computing mechanisms are discussed. Economic predictions are made based on the progress of the computer era.

DUK.04:003

Duke U. [Dept. of Mathematics] Durham, N. C.

LOGICAL CHARACTERIZATION OF AUTOMATA, by S. G. Campbell and G. H. Rosser, Jr. Sept. 1957, 9p. incl. diag. table. (AFOSR-TN-57-706) (AF 18(600)1539) AD 136700 Unclassified

Some of the theories developed by A. W. Burke and H. Wang in The Logic of Automata are explained with respect to the analysis of fixed, deterministic automata by state tables. The illustrations depend largely on the logical algebra of propositional calculus, the 2-valued logic.

DUK.04:004

Duke U. [Dept. of Mathematics] Durham, N. C.

AN ANALYSIS OF CARRY TRANSMISSION IN COMPUTER ADDITION, by S. G. Campbell and G. H. Rosser, Jr. Sept. 1957 [25]p. incl. diagrs. tables. (AFOSR-TN-57-

707) (AF 18(600)1539) AD 136701 Unclassified

Methods of facilitating carry transmission in binary addition were considered by introducing some operations of the classical 2-valued logic in which events are true or false, a pair of steady states which can be represented by 1 and 0, respectively. The operations considered are conjunction ($a \cdot b$ or ab), negation (inversion) \bar{a} , inclusive disjunction ($a \vee b$), and exclusive disjunction ($a \oplus b$). Various methods are presented for handling carry transmission that make it possible to transform immediately any information about binary carry into equivalent information about any transformed circuit.

DUK.04:005

Duke U. [Dept. of Mathematics] Durham, N. C.

GAUSSIAN INTEGRATION FOR THE DIGITAL COMPUTER, by S. G. Campbell. Sept. 1957, 32p. (AFOSR-TN-57-708) (AF 18(600)1539) AD 136702 Unclassified

Possible increase in the efficiency of an automatically produced code is considered from the standpoint of numerical quadrature. The general quadrature problem is studied for suggestions applicable to machine application which are to be inferred from classical techniques of approximation. The importance of numerical integration is emphasized for physical problems for which analytical methods fail. The numerical quadrature problem consists in, if $f(x)$ is given, finding $\int_a^b f(x)dx$ in terms of values of $f(x)$ for $a \leq x \leq b$. In particular, expressions of the form: $\int_a^b w(x)f(x)dx \approx \sum_{i=1}^n W_i f(x_i)$

where the x_i are real and $a \leq x_i \leq b$ for each i are considered. Gaussian quadrature formulas are also discussed and general purpose numerical integration programs are studied for characteristics which would lend themselves to a more optimal programming. To this end, various integration formulas are analyzed.

DUK.04:006

Duke U. [Dept. of Mathematics] Durham, N. C.

[RESEARCH IN NUMERICAL ANALYSIS], by S. G. Campbell. Final technical rept. Jan. 1958, 9p. (AFOSR-TR-58-11) (AF 18(600)1539) AD 148091 Unclassified

A brief description is given of the activities carried out under this contract from Sept. 16, 1955 - Sept. 15, 1957. Five technical notes were produced during this period.

DUK.03:071 - DUK.03:074

DUK.03:071

Duke U. Microwave Lab., Durham, N. C.

SUB MILLIMETER WAVE SPECTROSCOPY: ROTATION-INVERSION TRANSITIONS IN ND_3 , by G.

Erlandsson and W. Gordy. [1957] [13]p. incl. diagrs. tables, refs. (AFOSR-TN-57-47) (Bound with its Quarterly progress rept. no. 16, Nov. 1, 1956-Feb. 1, 1957) (AF 18(600)497) AD 115086 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 212, Apr. 25, 1957.

Also published in Phys. Rev., v. 106: 513-515, May 1, 1957.

The $J = 0 - 1$ rotational transition of N^{14}D_3 has been measured at a wavelength of 0.97 mm. This transition is split into two components by inversion doubling of the ground vibrational levels. The frequencies of the two components were found to be 306 735.0 mc/sec and 309 909.35 mc/sec. Their separation, 3174.4 mc/sec, is equivalent to the sum of the inversion frequencies of the upper and lower states. The relative intensities of the upper and lower frequency components were found to be about 10 to 1, in agreement with theory. The B_0 value, 154 162.7 mc/sec, is obtained from the arithmetic mean of the two components, with the infrared value, $D_J = 3.4$ mc/sec. The B_0 value is consistent with a bond length of 1.0144 Å and a bond angle of 107° . Superimposed upon each of the inversion components is a triplet hyperfine structure caused by the N^{14} quadrupole moment. This structure was measured for the higher frequency component, and the value, $eQq = -4.20 \pm 0.15$ mc/sec, was obtained for the N^{14} coupling. (Contractor's abstract)

electron can give specific information about the radiation damage in proteins, nucleic acids and many other biologically significant chemicals. The structures of their electron resonances show that free radicals of various types are formed from the different amino acids and simpler peptides by ionizing radiations. However, in numerous proteins only two structural patterns are obtained, either separately or in combination. One of these is like the common pattern obtained for cysteine, cystine, and glutathione and is believed to arise from an unpaired electron (electron hole) on the protein sulfur. The other pattern (obtained alone in proteins which have no sulfur) is a doublet characteristic of the interaction of the electron spin with the spin of a single proton. The latter appears to arise from an electron on a carbonyl oxygen interacting with a proton of the hydrogen bridge, or possibly on a $-\text{CH}-$ of the peptide chain which has lost an R side group. There is no evidence that the ionizing radiation breaks the polypeptide backbone structure of the proteins. The results seem to require that an electron hole or vacancy created at a given location in the protein molecule can migrate to other locations where it has lower energy.

DUK.03:073

Duke U. Microwave Lab., Durham, N. C.

FREE RADICALS AS A POSSIBLE CAUSE OF MUTATIONS AND CANCER, by W. Gordy. [1957] [10]p. incl. diagr. (AFOSR-TN-57-256) (Bound with its Quarterly progress rept. no. 17, Feb. 1, 1957-May 1, 1957; AD 126553) (AF 18(600)497) AD 126553(a) Unclassified

Also published in Proc. of Symposium on Information Theory in Biology, Gatlinburg, Tenn. (Oct. 29-31, 1956), New York, Pergamon Press, 1958, p. 353-356.

The hypothesis set forth in this note is that free radicals produced outside the body may find their way into the body and produce mutations and/or cancer. The evidence for support of this hypothesis is the presence of radicals as detected by microwave paramagnetic resonance in several carcinogenic agents, and the fact that free radicals are now recognized by radiobiologists as being responsible for a large portion of mutagenic and carcinogenic effects of ionizing radiations.

DUK.03:074

Duke U. Microwave Lab., Durham, N. C.

ELECTRON SPIN RESONANCE IN THE STUDY OF RADIATION DAMAGE, by W. Gordy. [1957] [66]p. incl. diagrs. (AFOSR-TN-57-255) (Bound with its Quarterly progress rept. no. 17, Feb. 1, 1957-May 1, 1957; AD 126533) (AF 18(600)497) AD 126533(b) Unclassified

Also published in Proc. of Symposium on Information Theory in Biology, Gatlinburg, Tenn. (Oct. 29-31, 1956), New York, Pergamon Press, 1958, p. 241-261.

It has been demonstrated by a Duke U. microwave group that the electron spin resonance of the resulting unpaired

A HIGH TEMPERATURE MOLECULAR BEAM MICROWAVE SPECTROMETER, by A. K. Garrison and W. Gordy. [1957] [6]p. incl. diagrs. (AFOSR-TN-57-544) (Bound with its Quarterly progress rept. no. 18, May 1, 1957-Aug. 1, 1957) (AF 18(600)497) Unclassified

DUK.03:075 - DUK.03:078

Also published in Phys. Rev., v. 108: 899-900, Nov. 1, 1957.

It has been reported that microwave energy in the 3 mm region has been absorbed in a molecular beam experiment. Line widths which are one order of magnitude smaller than previously have been reported for the KCl absorption lines.

DUK.03:075

Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE IN X-IRRADIATED PLASTICS AND SYNTHETIC FIBERS (Abstract), by H. Shields, W. B. Ard, and W. Gordy. [1957] [1]p. (Sponsored jointly by Office of Ordnance Research and Air Force Office of Scientific Research [under AF 18-(600)497]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 227, Apr. 25, 1957.

Microwave paramagnetic resonance has been used to study the effects of ionizing radiation on various plastics and synthetic fibers. The strength of the resonances obtained was found to depend on the degree of crystallinity. A sample of ordinary polyethylene gave no resonance signal after x-irradiation, whereas a similarly irradiated sample of polyethylene (supplied by Phillips Petroleum Company) which has a crystallinity above 90% gave a strong resonance with a seven-component proton hyperfine structure. Strong resonances have been obtained for x-irradiated polystyrene (single sharp line), Teflon (eight-component F^{19} hyperfine structure), Kel-F (unresolved hyperfine structure of several components), polyvinyl fluoride and chlorotrifluoroethylene (broad single resonances), polystyrene (single sharp resonance), nylon (asymmetric structure of four components), and Orlon (unresolved hyperfine structure of several components).

DUK.03:076

Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE OF RADICALS PRODUCED BY ULTRAVIOLET IRRADIATION (Abstract), by H. N. Rexroad and W. Gordy. [1957] [1]p. [AF 18-(600)497] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 227, Apr. 25, 1957.

The radicals produced by ultraviolet irradiation of solutions of various substances in the mixture ether, isopentane, and alcohol (EPA) and frozen at 77°K have been investigated by their microwave electron spin resonance. The EPA mixture, one commonly employed as a solvent by optical spectroscopists, was itself found to give no resonance under uv irradiation at 77°K. At 0.1 M solution of toluene ($C_6H_5CH_3$) in EPA showed a quartet resonance of 80 gauss spread which can be attributed to the CH_3 radical and a single component which might arise from the radical C_6H_5 . Thus the results indicate that the uv simply breaks the C C bond which ties the CH_3 to the ring. Interestingly, similar results are obtained for phenol, C_6H_5OH , in EPA. Tentatively, we interpret this to mean that the OH radical is produced by the uv but that it immediately attacks the EPA to form the CH_3 radical and an alcohol. A single moderately sharp resonance is obtained for benzoyl chloride, $C_6H_5(CO)Cl$. This is believed to arise from the C_6H_5CO radical. Probably the Cl produced at the same time would escape through the EPA.

DUK.03:077

Duke U. [Microwave Lab.] Durham, N. C.

MILLIMETER WAVE CELL FOR PRECISION MEASUREMENTS OF BOTH π AND σ STARK COMPONENTS (Abstract), by B. Bhattacharya, W. Gordy, and O. Fujii. [1957] [1]p. [AF 18(600)497] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 213, Apr. 25, 1957.

A parallel plate Stark cell has been constructed which allows precision measurements of both $\Delta M = 0$ and $\Delta M = \pm 1$ Stark components of molecular transitions occurring in the shorter millimeter wave region. Precise measurements have been made on HCN for both the $\Delta M = 0$ and $\Delta M = \pm 1$ components and for low, intermediate, and high field values. Nuclear magnetic coupling has been detected and measured in HCN, and a more precise value for the N^{14} quadrupole coupling has been obtained.

DUK.03:078

Duke U. [Microwave Lab.] Durham, N. C.

PRECISION MEASUREMENTS OF MILLIMETER AND SUBMILLIMETER WAVE LINES OF CO (Abstract), by W. Gordy and M. J. Cowan. [1957] [1]p. [AF 18(600)-497] Unclassified

DUK.03:079 - DUK.03:080

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2:
212-213, Apr. 25, 1957.

The $J = 0-1$ line of CO was the first spectral transition measured in the 2-3 mm wave region. Further improvements in harmonic generators and detectors have made possible more precise measurements of this and higher rotational transitions occurring in the submillimeter region with a video-type spectrometer employing a slow sweep and high fidelity amplifier. We have obtained

$$\nu_0(J = 0-1) = 115\,271.195 \pm 0.015 \text{ mc/sec}$$

$$(J = 1-2) = 230\,537.974 \pm 0.030 \text{ mc/sec}$$

$$(J = 2-3) = 345\,795.900 \pm 0.090 \text{ mc/sec}$$

for $C^{12}O^{16}$ in the ground vibrational state. These yield

$$B_0 = 57\,635.965 \pm 0.008 \text{ mc/sec}$$

$$D_0 = 0.1838 \pm 0.0005 \text{ mc/sec}$$

From infrared wavelength measurements, Rank has obtained $B_0 = 1.922521 \pm 0.0000035 \text{ cm}^{-1}$ for $C^{12}O^{16}$. The ratio of our B_0 value to his yields the velocity of light as

$$c = 299\,793.7 \pm 0.6 \text{ km/sec}$$

which is in good agreement with the value, $c = 299\,793.0 \pm 0.3 \text{ km/sec}$, recommended by DuMond and Cohen. Actually the microwave B_0 of $C^{12}O^{16}$ is now known to an accuracy better than that of c , and further improvement in the infrared measurements could lead to a significant improvement in the value of the velocity of light.

DUK.03:079

Duke U. [Microwave Lab.] Durham, N. C.

SUBMILLIMETER WAVE SPECTROSCOPY: DCI (Abstract), by M. J. Cowan and W. Gordy. [1957] [1]p. [AF 18(600)497] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 212,
Apr. 25, 1957.

The $J = 0-1$ rotational transitions in DCI^{35} and DCI^{37} have been measured in the wavelength region of 0.93 mm. Nuclear hyperfine structure was observed for both the Cl and D nuclei. Preliminary results are

	For DCI^{35}	For DCI^{37}
$\nu_0(J = 0-1)$	323 295.70	322 349.48
in mc/sec	± 0.65	± 0.65
B_0 in mc/sec	161 656.09	161.182.93
r_0 in A	1.28125	1.28124
B_e in mc/sec	163 340.1	162 859.0
r_e in A	1.27462	1.27463
$eQq(Cl)$ in mc/sec	-67.3	-53.1

The values of r and of B employ the infrared D_0 and α_e

values by Pickworth and Thompson. Measurements and analysis of the deuterium hyperfine structure are not yet complete.

DUK.03:080

Duke U. [Microwave Lab.] Durham, N. C.

SUPERCONDUCTIVITY AT MILLIMETER WAVE FREQUENCIES (Abstract), by G. S. Blevins, W. Gordy, and W. M. Fairbank. [1957] [1]p. (Sponsored jointly by Office of Ordnance Research and Air Force Office of Scientific Research [under AF 18(600)497])

Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 183,
Apr. 25, 1957.

The development at Duke University of refined millimeter wave techniques for the 0.5 to 5 mm region made possible investigations of the temperature dependence of the surface resistance of superconducting tin in the frequency region where $h\nu \approx kT$. In the first experiments the onset of superconductivity, as evidenced by a noticeable change in the high-frequency surface resistance, was found to depend on the frequency. These measurements have been extended to different types of surfaces. More sensitive methods have been developed for ascertaining small changes in resistance near the transition temperature. A new cryostat and microwave system has been constructed which makes possible a significant extension of the measurements to frequencies above 150 kmc/sec. In both plated surfaces and surfaces made from the bulk metal, the transition temperature was found to shift to lower temperatures as the frequency was increased above 50 kmc/sec in agreement with the earlier measurements. However, the amount of the shift was found to be less in the bulk metal surface than in the plated surface. It possibly depends on the width of the intermediate state.

DUK.03:081 - DUK.03:084

DUK.03:081

Duke U. [Microwave Lab.] Durham, N. C.

CHARACTERISTIC ELECTRON-SPIN RESONANCES OF FREE RADICALS WITHIN SOLIDS (Abstract), by W. Gordy. [1957] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)497] and Office of Ordnance Research)

Unclassified

Published in Program for Symposium on The Formation and Stabilization of Free Radicals, Nat'l. Bur. Standards, Washington, D. C. (Sept. 18-20, 1957), Washington, Nat'l. Bur. Standards, 1957, p. K1-K2.

Hydrocarbon free radicals have been produced by x and UV irradiation of numerous organic and biological substances in the solid state, and their characteristic electron spin resonances observed by various members of the Duke Microwave Lab. Nuclear hyperfine structure and other factors allow reasonably definitive identification of certain of the radicals, including the methyl and ethyl radicals and reasonably good guesses as to the identity of others. Our rather extensive observations revealed that the isotropic Fermi-type interaction with the proton spins is much larger in aliphatic hydrocarbon radicals than had previously been supposed and that the orientation-dependent dipole-dipole coupling is less significant than was thought. In fact, the isotropic coupling due to s orbital occupancy of the H atoms by the odd electron is generally much larger than the residual direct dipole-dipole interactions. It is this fortunate but unexpected circumstance which allows one to resolve the numerous hyperfine patterns in polycrystalline or amorphous solids. Another surprising fact is that symmetrical patterns indicating equivalent coupling of four or more protons in a single radical is often observed. To get the geometrical symmetry apparently needed to account for the equivalent coupling of an even number of protons in a simple aliphatic radical, charged radicals such as $(C_2H_4)^+$

were first postulated. However, the problem of accounting for the equivalent coupling of an odd number of five or more protons in radicals where a static geometrical symmetry does not appear possible. It is now thought that hydrogen exchange between adjacent carbons in aliphatic radicals occurs, and at a sufficient frequency to equalize the coupling of the protons during the lifetime in the spin states. Such an exchange could account for equalization of coupling of hydrocarbon radicals with even as well as odd numbers of hydrogens and could also account for much of the reduction in the dipole-dipole coupling already mentioned. Other motions of the radicals as well as the delocalization of the wave function of the odd electron also help to reduce the anisotropic dipole-dipole coupling. Hydrogen exchange between C atoms in radicals, if it occurs as indicated, should have important consequences in organic chemistry and biology. Results at elevated, medium and low temperatures and upon single

crystals as well as upon polycrystalline materials will be reported.

DUK.03:082

[Duke U. Microwave Lab., Durham, N. C.]

PROCEEDINGS OF CONFERENCE ON RADIO AND MICROWAVE SPECTROSCOPY, Duke U., Durham, N. C. (Nov. 4-6, 1957), Washington, Office of Naval Research [1957] 95p. incl. illus. diagra. tables, refs. (Office of Naval Research Symposium rept. no. ACR-31) (Sponsored jointly by Air Force Office of Scientific Research, under [AF 18(600)497], Office of Ordnance Research, and Office of Naval Research)

Unclassified

A representative group of experts were brought together to inform one another of the most significant developments in their respective specialties which included: nuclear magnetic resonance, paramagnetic resonance, ferrimagnetic resonance, and radio-frequency spectroscopy.

DUK.03:083

Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE TO PEPTIDES, by G. McCormick and W. Gordy. [1958] [42]p. incl. diagra. (AFOSR-TN-58-133) (Also bound with its Quarterly progress rept. no. 20, Nov. 1, 1957-Feb. 1, 1958; AD 153951) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)497 and Office of Ordnance Research) AD 152160

Unclassified

Also published in Jour. Phys. Chem., v. 62: 783-789, July 1958.

Free radicals produced by x-irradiated dipeptides and tripeptides have been investigated by the use of electron spin resonance methods. The hyperfine interaction with the hydrogen nuclei has been used to identify some of the radicals. Each peptide has generally been found to have characteristic resonance patterns. Oxygen has been found to kill or alter the pattern and sulfur or tyrosine rings act as protective agents against radiation damage to the rest of the protein or polypeptide.

DUK.03:084

Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE TO AMINO ACIDS, by H. Shields and W. Gordy. [1958] [54]p. incl. diagra. (AFOSR-TN-58-134) (Also bound with its Quarterly rept. no. 20, Nov. 1, 1957-Feb. 1, 1958; AD 153951) (Sponsored jointly by Air Force

DUK.03:085 - DUK.03:088

Office of Scientific Research under AF 18(600)497 and
Office of Ordnance Research) AD 152161

Unclassified

Also published in Jour. Phys. Chem., v. 62: 789-798,
July 1958.

Characteristic electron spin resonance patterns have been found for all the basic amino acids. Many of these patterns arise from the hyperfine interaction with the hydrogen nuclei. A g factor anisotropy gives rise to similar patterns for cysteine, cystine, and glutathione and it is believed that the odd electron is localized on the sulfur atom. Tyrosine and tryptophan do not have resolvable structure patterns which suggests that the odd electron migrates within the unsaturated rings. Sulfur groups and tyrosine and tryptophan rings serve to protect against radiation damage to the molecule. Some of the free radicals have been tentatively identified.

DUK.03:085

Duke U. [Microwave Lab.] Durham, N. C.

MILLIMETER-WAVE SPECTRUM OF FORMIC ACID, by G. Erlandsson. [1958] [19]p. incl. diagrs. tables, refs. (AFOSR-TN-58-274) (Also bound with its Quarterly progress rept. no. 19, Aug. 1-Nov. 1, 1957; AD 206418) (AF 18(600)497) AD 154175 Unclassified

Also published in Jour. Chem. Phys., v. 28: 71-75, Jan. 1958.

The investigation of the R^2 branch of the formic acid rotational spectrum has been extended up to $J = 9$ in the 1.5 mm wavelength region. The centrifugal distortion corrections have been studied in some detail partly by means of sum-rules and partly by power-series expansions and other approximate methods. (Contractor's abstract)

DUK.03:086

Duke U. Microwave Lab., Durham, N. C.

PRECISION MEASUREMENTS OF MILLIMETER AND SUBMILLIMETER WAVE SPECTRA: DCI, DBr, and DI, by M. [J.] Cowan and W. Gordy. [1958] [13]p. incl. diagrs. tables, refs. (AFOSR-TN-58-351) (Bound with its Quarterly progress rept. no. 22, May 1, 1958-Aug. 1, 1958) (AF 18(600)497) AD 154256 Unclassified

Also published in Phys. Rev., v. 111: 209-211, July 1, 1958.

Precision frequency measurements have been made on the $J = 0 - 1$ rotational transitions on the deuterium halides DCI, DBr, and DI. The measurements have been used to derive the following atomic constants: resonance frequency, the magnitude of quadrupole and magnetic

coupling, the hypothetical equilibrium distance r_e and the average distance in the ground vibrational state r_0 , and the ground state constant B_0 and the equilibrium value B_e of the moment of inertia constant. The constants D_0

and α which have been obtained from infrared data were employed in the calculation of the B and r values.

DUK.03:087

Duke U. Microwave Lab., Durham, N. C.

A MOLECULAR-ORBITAL TREATMENT OF ISOTROPIC HYPERFINE INTERACTIONS IN SIMPLE ALIPHATIC RADICALS, by D. B. Chesnut. [1958] [18]p. incl. diagrs. tables, refs. (AFOSR-TN-58-352) (Bound with its Quarterly progress rept. no. 21, Feb. 1, 1958-May 1, 1958) (AF 18(600)497) AD 154257 Unclassified

Also published in Jour. Chem. Phys., v. 29: 43-47, July 1958.

The problem of isotropic hyperfine interactions in the EPR spectra of aliphatic free radicals is approached from the molecular-orbital picture of hyperconjugation. The ethyl, methylethyl, and 1,1-dimethylethyl radicals are treated by this approximation; with a reasonable choice of parameters, the results can be correlated rather well with our present knowledge of aliphatic radicals. The calculated coupling constants of methyl group hydrogens are of the order of 15 to 25 gauss, do not decrease radically with the presence of additional methyl groups, and are very nearly proportional to the molecular-orbital unpaired electron density at the central carbon atom. (Contractor's abstract)

DUK.03:088

Duke U. Microwave Lab., Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE TO PROTEINS, by W. Gordy and H. Shields. [1958] [35]p. incl. diagrs. refs. (AFOSR-TN-58-353) (Bound with its Quarterly progress rept. no. 21, Feb. 1, 1958-May 1, 1958) (AF 18(600)497) AD 154258 Unclassified

Also published in Radiation Research, v. 9: 611-625, Dec. 1958.

The present study represents a continuation of an earlier investigation of the effects of ionizing radiation on the proteins with the method of electron spin resonance. It includes a number of proteins not in the preliminary work and gives further observations of certain ones which are in the earlier report. An orientation dependence of the resonance has been observed for silk strand and feather quill. Most, though not all, proteins investigated give

DUK.03:089 - DUK.03:091

either a doublet resonance characteristic of glycyl glycine, a field-dependent resonance characteristic of cystine, or a combination of the two. This is a surprising observation when one considers that the individual proteins are generally composed of some twenty different amino acids, almost all of which give characteristically different resonance patterns. The simpler peptides also give a variety of resonance patterns not found for the proteins. From the many types of long-lived spin resonances obtained for the amino acids and simpler peptides, one might predict extremely complex, probably unresolvable patterns for all proteins, patterns representing the superposition of several different radicals produced from different side groups or side chains of the proteins. The fact that this does not occur reveals a property of the proteins which may be important to the understanding of some of their biological functions as well as their reaction to ionizing radiations. References to the methods and theory of electron spin resonance are given in the other papers. (Contractor's abstract)

DUK.03:089

Duke U. Microwave Lab., Durham, N. C.

ELECTRON SPIN RESONANCE OF FREE RADICALS IN IRRADIATED BIOCHEMICALS, by W. Gordy. [1958] [48]p. incl. diagrs. refs. (AFOSR-TN-58-729) (Bound with its Quarterly progress rept. no. 22, May 1, 1958-Aug. 1, 1958) (AF 18(600)497) AD 162264

Unclassified

Presented at Internat'l. Congress of Radiation Research, Burlington, Vt., Aug. 11-15, 1958.

Also published in Radiation Research, Suppl., v. 1: 491-510, 1959.

This review paper describes some of the general conclusions which have been found in the study of 25 amino acids and like number of di- or tripeptides and many proteins which have been x-irradiated. There are 16 domestic and foreign references given which cover a time period from 1949-1957.

DUK.03:090

Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED TEFLON: EFFECTS OF VARIOUS GASES, by H. N. Rexroad and W. Gordy. [1958] [16]p. incl. diagrs. refs. (AFOSR-TN-58-870) (Bound with its Quarterly progress rept. no. 23, Aug. 1-Nov. 1, 1958) (AF 18(600)-497) AD 203715

Unclassified

Also published in Jour. Chem. Phys., v. 30: 399-403, Feb. 1959.

The radical produced by x- or γ -irradiation of polyfluoroethylene (Teflon) in a high vacuum is shown to have five F atoms with nuclear coupling to the electron spin, four with equivalent coupling of 33 gauss each and a fifth with coupling of 92 gauss. The radical is probably of the form $\text{XCF}_2\text{CFCF}_2\text{Y}$, where X and Y represent the continuing

Teflon chains with no significant electron spin density. Molecular oxygen was found to combine with undetectable radicals or ions in the irradiated Teflon to produce a new resonance. Carbon monoxide alters the latter resonance to a different one while H_2 , NO, and ionized air kill it. The resonance of the fluorocarbon radical is also nullified by H_2 and NO. When Teflon is irradiated under an atmosphere of NO gas, a triplet resonance structure apparently arising from N^{14} nuclear interaction is produced. The triplet can also be produced by admission of NO to a sample of Teflon previously irradiated in a vacuum. (Contractor's abstract)

DUK.03:091

Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE IN AN IRRADIATED SINGLE CRYSTAL OF DIMETHYLGLYOXIME, by I. Miyagawa and W. Gordy. [1958] [28]p. incl. diagrs. tables. (AFOSR-TN-58-1034) (Bound with its Quarterly progress rept. no. 23, Aug. 1-Nov. 1, 1958) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)497] and Office of Ordnance Research) AD 206484

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

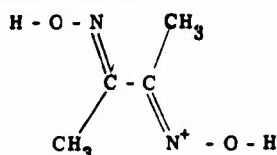
Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 179, May 1, 1958.

Also published in Jour. Chem. Phys., v. 30: 1590-1595, June 1959.

The paramagnetic resonance of γ -irradiated single crystals of dimethylglyoxime has been measured at 23 kmc/sec and 9 kmc/sec for various orientations of the crystal in the magnetic field. The resonance pattern was found to have a triplet structure caused by a coupling to a single N^{14} nucleus. Both the nuclear coupling and the spectroscopic splitting factor were found to be anisotropic with the principal values: $A_1 = 45 \pm 1$ gauss, $A_2 = A_3 = 25 \pm 1$ gauss, $g_1 = 2.0026 \pm 0.0003$, $g_2 = 2.0063 \pm 0.0003$, and $g_3 = 2.0095 \pm 0.0003$. It is concluded that the free radical produced by the irradiation is probably the

DUK. 03:092-094; DUK. 05:001

ionized dimethylglyoxime molecule



with the positive charge and the electron spin density concentrated on one of the nitrogens and in an hybridized sp^2 -orbital which is approximately in the molecular plane and along the bisector of the $\text{C} = \text{N} - \text{O}$ angle.

The s-character in the bond is calculated from the N^{14} coupling to be 19%. (Contractor's abstract)

irradiated Teflon reported earlier have been further investigated. With samples having large surface area it was found that a strong new signal could be produced by the introduction of O_2 without a noticeable change in the resonance already produced by irradiation of the Teflon in vacuum. A similar effect was observed for NO. It is concluded that the paramagnetic O_2 and NO are trapped on or near the surface of the Teflon by ions or radicals which are produced by the irradiation and which do not themselves give an observable paramagnetic resonance. No such effects were observed for N_2 , CO_2 , and CO, although CO was found to reduce the signal observed for the trapped O_2 . Ionized air was found to kill quickly the resonance of the trapped O_2 .

DUK.03:092

Duke U. [Microwave Lab.] Durham, N. C.

CYCLOTRON RESONANCE IN FLAMES, by J. Schneider and F. W. Hofmann. [1958] [3]p. incl. diagr. (AFOSR-TN-58-1035) (Bound with its Quarterly progress rept. no. 23, Aug. 1-Nov. 1, 1958) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)-497], Office of Naval Research, and California Research Corp.) AD 206481
Unclassified

Also published in Phys. Rev. Letters, v. 1: 408-409, Dec. 1, 1958.

Cyclotron resonance of electrons in a gas discharge has been detected in low pressure flames at a frequency near 24 kmc/sec. In an acetylene-air flame, at K-band frequencies and at atmospheric pressure no indication of a cyclotron resonance was found, whereas at 100 mm Hg a broad absorption appeared which became considerably sharper as the pressure was decreased. A recorder trace of the cyclotron resonance line was observed from an acetylene-oxygen flame at 7.5 mm Hg. Electron concentrations and collision frequencies were determined.

DUK.03:094

Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE OF FREE RADICALS AT LIQUID HELIUM TEMPERATURES (Abstract), by F. Patten, G. McCormick, and W. Gordy. [1958] [1]p. [AF 18(600)497]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 179, May 1, 1958.

Electron spin resonances of CH_3 , C_2H_5 , and a number of other free radicals produced by irradiation of solids at room or liquid nitrogen temperatures have been observed at 4.2°K. Proton hyperfine structures of some of the resonances undergo qualitative changes as the temperature is lowered, whereas others do not. The changes depend markedly upon the nature of the medium in which the radicals are trapped. They are generally reversible, i.e., the original pattern of the resonance is restored when the temperature is again raised.

DUK.03:093

Duke U. [Microwave Lab.] Durham, N. C.

EFFECTS OF ABSORBED GASES ON FREE RADICAL RESONANCES IN SOLIDS (Abstract), by H. [N.] Rexroad and W. Gordy. [1958] [1]p. [AF 18(600)497]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 179, May 1, 1958.

The effects of O_2 on the free radical resonance of x-

DUK.05:001

Duke U. School of Medicine, Durham, N. C.

THE MECHANISM OF COUGH SYNCOPE, by H. D. McIntosh, E. H. Estes, and J. V. Warren. [1956] [13]p. incl. illus. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542, American Heart Association, and National Institutes of Health)
Unclassified

Published in Amer. Heart Jour., v. 52: 70-82, July 1956.

The effect of cough on the cardiorespiratory system in 13 patients with cough syncope and a group of 100 normal

DUK.05:002 - DUK.05:004

patients is reported. The response to coughs in these 2 groups differed only in magnitude. These studies suggest that syncope due to coughs is the result of the transmission of markedly elevated intra-thoracic and intra-abdominal pressure to the cerebro-spinal fluid compartment causing an essentially equal rise of the latter pressure. The results of this study are in agreement with reports of Baker and of Kerr and Derbes which suggest that cough syncope is a common form of fainting.

DUK.05:002

Duke U. School of Medicine, Durham, N. C.

OBSERVATIONS ON THE CENTRAL VENOUS RESERVOIR AS A DETERMINANT OF CARDIAC OUTPUT, by A. M. Weissler, J. J. Leonard, and J. V. Warren. [Mar. 1957] 8p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542, American Heart Association, and National Institutes of Health)
Unclassified

Observations have been carried out on 12 normal subjects demonstrating that in the horizontal position intra-venous atropine causes a considerable increase in cardiac output, primarily due to increased heart rate. In the passive upright position, despite even greater increases in heart rate, cardiac output is altered only slightly from the control observations in the upright position. Application of an antigravity suit in part restores cardiac responsiveness in the passive upright position. These data support the thesis that the central venous reservoir is an important determinant of cardiac responsiveness. (Contractor's abstract)

DUK.05:003

Duke U. School of Medicine, Durham, N. C.

VASODEPRESSOR SYNCOPE: ACUTE CIRCULATORY DISORGANIZATION. AN EXPERIMENTAL STUDY OF FACTORS INFLUENCING CARDIAC OUTPUT, by A. M. Weissler, J. V. Warren and others. [Mar. 1957] [27]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-1542, American Heart Association, and National Institutes of Health)
Unclassified

Also published in *Circulation*, v. 15: 875-882, June 1957. (Title varies)

Postural syncope can be produced with facility by 60° headup tilt with the aid of sodium nitrite. Syncope so induced is similar to spontaneous vasodepressor syncope, and offers an experimental technique for the study of blood pressure and cardiac output regulation. The cardiac output in vasodepressor syncope tends to fall slightly. During recovery, the cardiac output rises at times to supernormal levels. Of particular interest, is

the failure of the cardiac output to compensate for the fall in peripheral resistance during syncope. The occurrence of either neurogenic myocardial inhibition, or markedly limited venous inflow were investigated as possible explanations for this finding. Atropinization prevents the relative bradycardia during syncope, but does not alter the cardiac output response. Antigravity suit inflation or negative pressure breathing rapidly reverses the syncopal reaction. The improvement following antigravity suit inflation is associated with a rise in cardiac output, and insignificant changes in peripheral resistance. Albumin infusions were found to prevent syncope. The arterial CO₂ constant falls at the height of syncope.

This fall is probably secondary to the hyperventilation during syncope, and contributes to the circulatory embarrassment by further lowering peripheral resistance and cerebral blood flow. The major circulatory event of vasodepressor syncope would appear to be not only widespread loss of peripheral resistance, but its occurrence in the face of inability of the heart to compensate by an increase in output. Present evidence favors the causative role of limited inflow in restricting the cardiac output response. (Contractor's abstract)

DUK.05:004

Duke U. School of Medicine, Durham, N. C.

EFFECTS OF POSTURE AND ATROPINE ON THE CARDIAC OUTPUT, by A. M. Weissler, J. J. Leonard, and J. V. Warren. [1957] [7]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542, American Heart Association, and National Institutes of Health)
Unclassified

Published in *Jour. Clin. Invest.*, v. 36: 1656-1662, Dec. 1957.

The cardiac output response to tachycardia induced by the intravenous administration of atropine sulfate has been studied in twelve normal subjects in recumbency and tilted head up at 60 degrees. In four instances the effects of antigravity suit compression on the response to atropine in tilted subjects were studied. In five subjects the effects of peripheral venous pooling of blood on the response to atropine were also observed. Significant increases in cardiac output, primarily the result of increased heart rate with little change in mean stroke volume, occurred in recumbent subjects. Only slight elevation of cardiac index, despite even greater tachycardia associated with a fall in mean stroke volume, occurred in the tilted group. Similar results following atropine were seen during peripheral pooling of blood. Sustained antigravity suit inflation restored, in part, the cardiac responsiveness to atropine in tilted subjects. These data support the thesis that the central venous reservoir is an important determinant of cardiac responsiveness.

DUK.05:005 - DUK.05:008

DUK.05:005

Duke U. School of Medicine, Durham, N. C.

GALLOP RHYTHM, by J. V. Warren, J. J. Leonard, and A. M. Weissler. [1958] [17]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542, American Heart Association, and National Institutes of Health) Unclassified

Published in Ann. Internal Med., v. 48: 580-596, Mar. 1958.

The various types of diastolic heart sounds are reviewed. The factors influencing audibility are considered as well as mechanism of production and clinical significance. The simple unitarian concept of gallop rhythm has been superseded by a more complicated but more rational concept. Although relatively elaborate means are required for critical analysis, careful auscultation at the bedside will enable the physician to differentiate between various types of gallop sounds, and would appear to increase his efficiency as a diagnostician.

DUK.05:006

Duke U. School of Medicine, Durham, N. C.

"NORMAL VOLUNTEER SUBJECTS": THEIR PERSONALITY PROFILES (Abstract), by M. D. Bogdonoff, J. J. Combs, Jr. and others. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542, American Heart Association, and National Institutes of Health) Unclassified

Published in Clin. Research, v. 6: 309, Apr. 1958.

A series of comprehensive personality interviews of the "volunteers" have been conducted. These interviews have consisted of a biographical account of family and home development, an inventory of feelings and attitudes, and reasons for volunteering. Twenty "volunteer" male subjects were studied. All were university students who were informed of the experiments either by word-of-mouth communication in the dormitories, or by a bulletin board announcement. Four subjects presented history patterns indicative of serious personality disorders, two with marked psychoneurotic patterns, and two with depressive illness. In 13 subjects, there was a history of one parent's being an extremely overbearing, aggressive individual, and these subjects universally reported the inability adequately to express their own feelings of hostility and aggression. Two of these individuals indicated a "need to experience pain and toughen up." Two subjects reported volunteering for these experiments shortly after undergoing intensely stressful difficulties in life adjustment. Six reported home backgrounds characterized by elements of intense discord. Life histories of 5 of the subjects appeared unremarkable. The incidence of

personality adjustment problems in "normal volunteer subjects" indicates that in the study of relationships between affect state and physiologic changes, the nature of the subject group must be taken into consideration.

DUK.05:007

Duke U. [School of Medicine] Durham, N. C.

THE EFFECT OF INDUCED ANXIETY AND HOSTILITY ON CARDIOVASCULAR FUNCTIONS (Abstract), by J. J. Combs, Jr., G. N. Bryant and others. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542, American Heart Association, and National Institutes of Health) Unclassified

Published in Jour. Clin. Invest., v. 37: 885, June 1958.

Although it is recognized that affect states may influence cardiovascular function, there is little information regarding the pattern of response and its mechanism of production. It may well be that such factors play an important role in determining the manifestations or even presence of organic cardiovascular disease. To study this problem, the authors observed the response of 23 normal male volunteers to induced variation in affect state produced by verbal and electrical stimuli. Heart rate, respiratory rate, arterial and central venous pressure were monitored on a photographic recorder. Cardiac output was determined by the dye technique. Following control determinations, change in affect state was attempted by suggesting an endangering personal situation or by a noxious stimulus (electric shock). Further circulatory observations were made at the point of apparent maximum emotional response. Conversational material was tape recorded, including a focused interview of the subject by an objective examiner immediately after the maximum response observations. These data were then reviewed for evaluation of affect state and only later correlated with the hemodynamic response. The magnitude of cardiovascular response varied directly with the evaluated intensity of the affect state, but could not be correlated with personality patterns derived from personal history. In both affect states the pattern of response was similar, and in some respects resembled that associated with epinephrine administration.

DUK.05:008

Duke U. School of Medicine, Durham, N. C.

OBSERVATIONS ON THE MECHANISM OF ATRIAL GALLOP RHYTHM, by J. J. Leonard, A. M. Weissler and others. [1958] [6]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542, American Heart Association, and National Institutes of Health) Unclassified

Published in Circulation, v. 17: 1007-1012, June 1958.

DUK.05:009 - DUK.05:010

An atrial gallop sound is a frequent finding in hypertensive cardiovascular disease, myocardial infarction, and in the presence of a prolonged atrioventricular conduction time. In view of evidence relating this sound to a ventricular pressure wave resulting from atrial contraction, modification of this hemodynamic event was studied by means of tourniquet pooling of blood in the extremities. In the eighteen patients studied, this maneuver caused striking changes in the intensity and timing of the atrial gallop. Analysis of these changes helps explain the frequent appearance of this triple rhythm in severe hypertensive cardiovascular disease. (Contractor's abstract)

DUK.05:009

Duke U. School of Medicine, Durham, N. C.

OBSERVATIONS ON THE DELAYED HEART SOUND IN MITRAL STENOSIS AND HYPERTENSION, by A. M. Weissler, J. J. Leonard, and J. V. Warren. [1958] [4]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-1542, American Heart Association, and National Institutes of Health) Unclassified

Published in Circulation, v. 18: 165-168, Aug. 1958.

The measurement of the time between the onset of ventricular depolarization and the first heart sound, the Q-1 interval, has been employed in the phonocardiographic evaluation of patients with rheumatic heart disease. Prolongation of this interval has been noted frequently

in patients with mitral stenosis and may be used as evidence in weighing the advisability of operation. In the present study, delayed appearance of the first heart sound was often noted in patients with hypertensive vascular disease as well. The mechanism for these changes as well as their significance in the phonocardiographic evaluation of patients with combined valvular disease and hypertension is discussed. (Contractor's abstract)

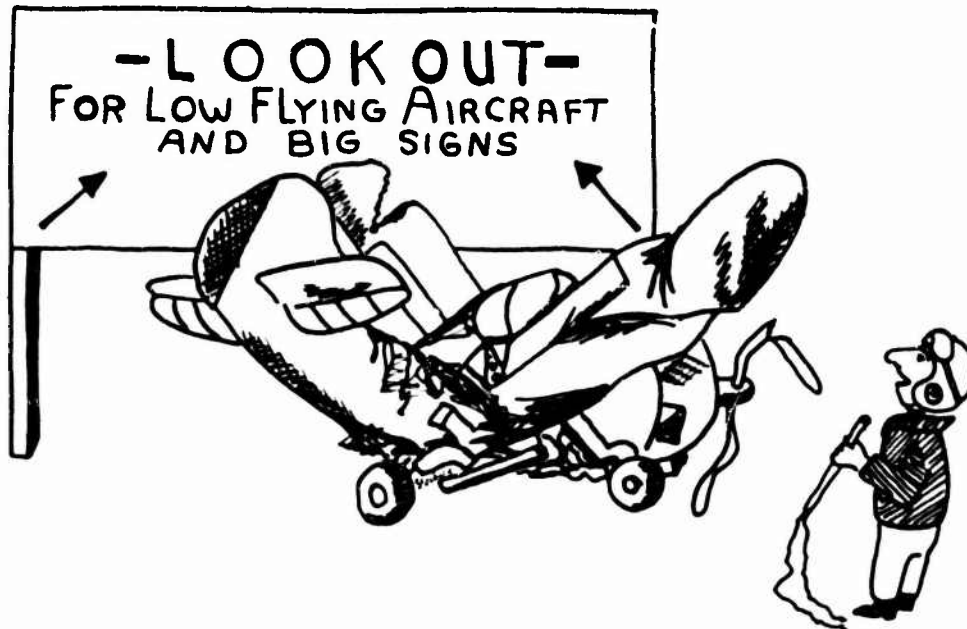
DUK.05:010

Duke U. School of Medicine, Durham, N. C.

MODIFICATION OF VENTRICULAR GALLOP RHYTHM INDUCED BY POOLING OF BLOOD IN THE EXTREMITIES, by J. J. Leonard, A. M. Weissler, and J. V. Warren. [1958] [5]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542, American Heart Association, and National Institutes of Health) Unclassified

Published in British Heart Jour., v. 20: 502-506, Oct. 1958.

The peripheral pooling of blood by venous occlusive tourniquets, with resultant alterations in pressure flow relationships within the heart, causes a diminution or disappearance of the ventricular gallop sound in most instances. This procedure may be useful in differentiating a ventricular gallop from an opening snap or a split second sound.



EMM.01:001; ESC.02:001-004

EMM.01:001

Emmanuel Missionary Coll. Dept. of Mathematics,
Berrien Springs, Mich.

APPLICATION OF THE THEORY OF LINEAR OPERATORS IN HILBERT SPACE TO POTENTIAL THEORY, by E. J. Specht and H. T. Jones. June 1957, 46p. incl. refs. (AFOSR-TN-57-306) (AF 13(600)756) AD 132377 Unclassified

A historical review and statement of the problem is presented. The properties of the kernel K are stated and their proof is discussed in some detail. An introduction and analysis of the properties of the Hilbert space and the operator, with expansions in terms of characteristic functions are included.

Enrico Fermi Inst. for Nuclear Studies, Chicago, Ill.
see Chicago U. Enrico Fermi Inst. for Nuclear
Studies, Ill.

ESC.02:001

Escher Wyss, Ltd., Zurich (Switzerland).

APPLICATION OF THE CLOSED-CYCLE PRINCIPLE TO AIRCRAFT PROPULSION SYSTEMS. VOLUME VI. GENERAL He-NAP CONSIDERATIONS, by A. Burgdorfer, R. Tognoni, and W. Spillmann. July 21, 1957, 1v. incl. diagrs. (Rept. no. Sp-AK-57-045; Z no. 5-862-619) (AFOSR-TR-58-30) (AF 61(514)985) AD 152239 Unclassified

A closed-cycle nuclear aircraft-propulsion plant is discussed. The plant consists of a main engine with a cooling fan, a reactor, a high-pressure turbine, a recuperator, a cooler, and a compressor. The propulsion system consists of 4 ducted fans driven by 4 low-pressure turbines in parallel. The cycle has neither intercooling nor reheat. To reduce the dimensions of the cycle components, a high-pressure level was selected (about a 1000-psi maximum cycle pressure). The nature of the gas, the high pressure, and the stress levels determine the smallest feasible power output to 51,000 hp which results in a heat-generating requirement of about 100 megawatt for the helium reactor. The dimensions of the turbo-machinery components are small, but removal of 6.24×10^4 Btu/sec requires a large cycle cooler. The ducted fans may be installed at any location in the aircraft. An aircraft for which the power plant would be suitable was sized and compared with the DC-8.

ESC.02:002

Escher Wyss, Ltd., Zurich (Switzerland).

APPLICATION OF THE CLOSED-CYCLE PRINCIPLE

TO AIRCRAFT PROPULSION SYSTEMS. VOLUME VII. GASEOUS WORKING MEDIA FOR CLOSED CYCLE POWER PLANTS, by W. Spillmann and B. Speckert. July 21, 1957, 1v. incl. diagrs. tables. (Rept. no. Sp-AK-57-046; Z no. 5-862-620) (AFOSR-TR-58-31) (AF 61(514)985) AD 152240 Unclassified

The comparative data of various gases were studied with respect to their behavior in thermal cycles. He, N_2 , and CO_2 are feasible as working media in nuclear power plants. For a nuclear air-propulsion plant, He is the best suited gas with respect to radiation stability and plant size. The excellent heat-transfer properties of He are of prime importance for the size of the heat-transfer equipment, which should be kept as small as possible.

ESC.02:003

Escher Wyss, Ltd., Zurich (Switzerland).

APPLICATION OF THE CLOSED-CYCLE PRINCIPLE TO AIRCRAFT PROPULSION SYSTEMS. VOLUME VIII. SIZING OF THE COMPONENTS OF A CLOSED-CYCLE He-NAP SYSTEM, by A. Burgdorfer, R. Tognoni, and W. Spillmann. July 21, 1957, 1v. incl. diagrs. (Rept. no. Sp-AK-57-047; Z no. 5-862-621) (AFOSR-TR-58-32) (AF 61(514)985) AD 152241 Unclassified

As a basis for the design of a helium (He) closed-cycle nuclear air propulsion plant, the following values were assumed: a compressor pressure ratio of 2.75, a compressor-turbine pressure ratio of 1.543, a cooling-fan turbine pressure ratio of 1.056, a propulsion fan turbine pressure ratio of 1.471, a compressor stage efficiency of 0.853, a compressor-turbine stage efficiency of 0.87, a cooling-fan turbine stage efficiency of 0.85, a propulsion-fan turbine stage efficiency of 0.87, a maximum compressor discharge pressure of 995 psia, a recuperator effectiveness of 0.9, and a He weight flow of 126.8 lb/sec.

ESC.02:004

Escher Wyss, Ltd., Zurich (Switzerland).

APPLICATION OF THE CLOSED CYCLE PRINCIPLE TO AIRCRAFT AUXILIARY POWER PLANTS. VOLUME IX. COMPARISON BETWEEN DIRECT AND INDIRECT HEAT ADDITION FROM AN ATOMIC REACTOR TO A CLOSED GAS TURBINE CYCLE, by R. Tognoni. July 21, 1957, 1v. incl. diagrs. tables. (Technical note no. 5; rept. no. Sp-AK-57-041; Z no. 5-862-610) (AFOSR-TR-58-33) (AF 61(514)985) AD 152242 Unclassified

The penalties for a double circuit in which heat is added by a heat exchanger in connection with an external heat source were investigated. For actual designs, the

ESC.02:005, 006; EXP.01:002

double-loop system needs a pumping power of 10 to 20% of useful power output. Where the reactor temperature is not limited, the thermal efficiency of the double loop is 4 to 9% lower than that for a single circuit in which the heat source is in the gas-turbine cycle itself. For a given maximum allowed reactor outlet temperature (1030°K), the thermal efficiency is up to 16% smaller than the efficiency of the simple direct cooling cycle. The absolute maximum efficiency can be the same for all gases because the pressure losses are smaller for gases with higher specific heat ratio. Thermal and pumping power losses are of such a magnitude in the double loop that single-loop systems are to be preferred for all applications where high efficiency is of primary interest.

ESC.02:005

Escher Wyss, Ltd., Zurich (Switzerland).

APPLICATION OF THE CLOSED CYCLE PRINCIPLE TO AIRCRAFT AUXILIARY POWER PLANTS. VOLUME X. HELIUM COMPRESSOR DESIGN, by R. Tognoni. July 21, 1957, 1v. incl. diagrs. tables. (Technical note no. 6; rept. no. Sp-AK-57-042; Z no. 5-862-611) (AFOSR-TR-58-34) (AF 61(514)985) AD 152243
Unclassified

The effect of different design parameters on compressor performance was investigated for a closed-cycle nuclear air-propulsion system in which helium is used as the working fluid. The blading of a model stage for the same requirements but with air as the working medium was designed in detail. A reaction of about 105% was the best compromise between good stage efficiency and a reasonable number of stages.

ESC.02:006

Escher Wyss, Ltd., Zurich (Switzerland).

APPLICATION OF THE CLOSED CYCLE PRINCIPLE

TO AIRCRAFT AUXILIARY POWER PLANTS. VOLUME XI. INVESTIGATION OF THE INFLUENCE OF THE FLOW FACTOR ON TURBINE EFFICIENCY, by R. Tognoni. July 21, 1957 [9]p. incl. diagrs. (Technical note no. 7; rept. no. Sp-AK-57-043; Z no. 5-862-613) (AFOSR-TR-58-35) (AF 61(514)985) AD 152244
Unclassified

Helium in a gas-turbine cycle requires turbo machinery with a large number of stages because of the small molecular weight of the helium. Higher tip speeds can be obtained with helium because of the high sonic velocity. The use of titanium which has the strength of steel but a density of only 4.5 would allow an appreciable increase in rpm and a decrease in the number of stages.

EXP.01:002

Experiment, Inc., Richmond, Va.

IGNITION AND FLAME PROPAGATION IN DUST CLOUDS, by L. E. Line, Jr. Final technical rept. Jan. 31, 1958, 36p. incl. illus. diagrs. tables, refs. (Rept. no. TP-131) (AFOSR-TR-58-94) (AF 18(600)1508) AD 162144; PB 137471
Unclassified

The ignition of dust columns of various finely divided solids (principally lycopodium) suspended in oxygen-diluent gas mixtures has been investigated under the various conditions of type of ignition source, rate and manner of introducing the energy, oxygen partial pressure, diluent gas, dust concentration, particle size, column confinement. A mechanism is offered to account for the effect of discharge time on the minimum energy or oxygen concentration for ignition. The spherical propagation of a point-source-initiated flame through dust clouds of magnesium and lycopodium has also been investigated. (Contractor's abstract)



FEA.01:001

[Fairchild Engine and Airplane Corp.] Fairchild Engine Div., Deer Park, N. Y.

SUPERSONIC COMBUSTION TUNNEL, by R. A. Gross. Design rept. Oct. 1, 1957, 38p. incl. illus. diagrs. tables. (AFOSR-TN-57-677) (AF 49(638)15) AD 136667 Unclassified

The major features incorporated in a supersonic combustion-research tunnel which was designed to permit experimental exploration of chemical energy release in supersonic flow are summarized. The tunnel, which is designed for steady-state operation, accelerates a homogeneous mixture of fuel and air to a test section at about $M = 3$. The tunnel is of fixed geometry, and the test section has an axial gradient from $M = 3.0$ to 3.5 . Inlet stagnation temperature in the tunnel can be varied from 300° to 1200°F , and inlet stagnation pressure can be varied from ambient to 140 psia. Test area in the tunnel is about 5 by 3 in.; the throat is about 1 by 3 in. Detailed information is provided on the aerodynamic design, heat transfer, structural design, operating analysis, and instrumentation associated with the tunnel. (Contractor's abstract)

FEA.01:002

[Fairchild Engine and Airplane Corp.] Fairchild Engine Div., Deer Park, N. Y.

MAGNETOHYDRODYNAMIC EFFECTS IN COMBUSTION, by R. A. Gross, W. Chinitz, and T. J. Rivlin. Feb. 15, 1958, 23p. incl. diagrs. table, refs. (AFOSR-TN-58-120) (AF 49(638)15) AD 152028 Unclassified

Also published in Jour. Aero/Space Sciences, v. 27: 283-290, Apr. 1960. (Title varies)

One dimensional steady flow with heat addition in the presence of a plane magnetic field transverse to the direction of motion is studied. The basic equations are derived and solved for a variety of ideal conditions. Particular emphasis is given to the singular solution (the analogue of the Chapman-Jouguet detonation). The presence of a magnetic field alters the classical conditions. The effects of variable fluid properties and finite electrical conductivity are discussed. The electrical conductivity of the product gases of hydrogen-air detonations is presented. The experimental implications of this analysis are examined and lead to the conclusion that large magnetohydrodynamic effects in combustion can be produced in the laboratory under special conditions. (Contractor's abstract)

FEA.01:003

[Fairchild Engine and Airplane Corp.] Fairchild Engine Div., Deer Park, N. Y.

THEORETICAL CALCULATIONS IN GASEOUS DETONATION, by C. L. Elsen, R. A. Gross, and T. J. Rivlin. Mar. 15, 1958, 93p. incl. diagrs. tables, refs. (AFOSR-TN-58-326) (AF 49(638)15) AD 154230; PB 135266 Unclassified

Also published in Combustion and Flame, v. 4: 137-147, Mar. 1960.

This study treats one dimensional steady flow combustion in the Mach number range of 0 to 10. Original data are presented for a wide variety of hydrocarbon fuels burning with air. Particular attention is given to the classical Chapman-Jouguet point. The results include the effect of dissociation and ionization. Non-dissociative results are also presented for both subsonic and supersonic flow and compared with the dissociative data. The effects of fuel-air ratio, initial temperature, and initial pressure are considered. Curves are presented which show not only the Chapman-Jouguet point, but the strong and weak detonation branches. Comparisons are made with other published works. These data were generated by the successful development of an automatic digital computer program. The program is applicable to any hydrogen, carbon, oxygen and nitrogen system. The theory, equations and method of solution are presented. The accuracy of the computation is discussed. These calculations are believed to be the most extensive of their kind ever made. (Contractor's abstract)

FEA.01:004

[Fairchild Engine and Airplane Corp.] Fairchild Engine Div., Deer Park, N. Y.

AEROTHERMODYNAMIC AND ELECTRICAL PROPERTIES OF SOME GAS MIXTURES TO MACH 20, by W. Chinitz, C. L. Elsen, and R. A. Gross. Oct. 1, 1958, 1v. incl. diagrs. tables, refs. (AFOSR-TN-58-869) (AF 49(638)15) AD 203666; PB 140848 Unclassified

Also published in ARS Jour., v. 29: 573-579, Aug. 1959.

Pressure, temperature, chemical composition and electrical conductivity data are presented for gas mixtures behind strong air shocks and detonations of hydrogen-air and acetylene-air mixtures up to Mach 20. A digital computer program was developed which solves the simultaneous aerodynamic and chemical equilibrium equations. The latest thermodynamic and collision cross section data are used. Data are also presented wherein the initial gas composition was varied to obtain the maximum electrical conductivity for a given shock or detonation strength. (Contractor's abstract)

FEA.01:005-007; FSL.01:001;
FLA.01:006

FEA.01:005

[Fairchild Engine and Airplane Corp.] Fairchild Engine
Div., Deer Park, N. Y.

RECENT ADVANCES IN GASEOUS DETONATION, by
R. A. Gross and A. K. Oppenheim. [1958] [7]p. incl.
illus. diagrs. table, refs. (In cooperation with
California U., Berkeley) (AFOSR-TN-58-898) (AF 49-
(638)15 and AF 49(638)166) AD 204131 Unclassified

Also published in APS Jour., v. 29: 173-179, Mar. 1959.

A review of recent work in gaseous detonation is pre-
sented. Early work is briefly mentioned and treatises
listed. Theoretical and experimental calculations of
Chapman-Jouguet detonations are reviewed, compared
and the ambiguity concerning the speed of sound in a
reacting gas mixture discussed. Studies of the interior
of a detonation wave, standing detonation wave research,
detonation limits, two-dimensional detonations, spectra,
ionization, and magnetohydrodynamic treatments are
brought to the reader's attention, as well as a qualitative
description of the development of a flame to a detonation.
(Contractor's abstract, modified)

FEA.01:005

[Fairchild Engine and Airplane Corp.] Fairchild Engine
Div., Deer Park, N. Y.

ON THE SPEED OF SOUND IN AIR, by R. A. Gross and
C. L. Eisen. [1958] [4]p. incl. diagrs. refs. (AFOSR-
TN-58-1027) [AF 49(638)15] AD 162294

Unclassified

Also published in Phys. Fluids, v. 2: 276-279, May-
June 1959.

In a high-temperature gas, the speed of sound depends
upon the chemical composition, sound frequency, and
chemical reaction rates. Two limiting sound speeds
are normally distinguished: that of "frozen" or constant
chemical composition, and the "equilibrium" sound
speed. Equations to determine these two sound speeds
are presented for a nitrogen-oxygen system and numeri-
cal data are presented for conditions behind a normal
shock in air to a speed of Mach 20. (Contractor's
abstract)

FFA.01:007

Fairchild Engine and Airplane Corp. Fairchild Engine
Div., Deer Park, N. Y.

A NOTE ON ONE-DIMENSIONAL PLASMA MOTION, by
R. A. Gross. [1958] [2]p. (AF 49(638)15) Unclassified

Published in Jour. Aero/Space Sciences, v. 25: 788-789,
Dec. 1958.

Some cases are given on the effects that can be expected
on the motion of a plasma which is subjected to an ex-
ternal magnetic field and which exchanges thermal energy
with its surroundings. The equations that govern the
motion of such a plasma are given. Plasma motion which
is steady and one-dimensional is discussed.

Fels Research Inst., Yellow Springs, Ohio.
see Antioch Coll. Fels Research Inst., Yellow Springs,
Ohio.

FSL.01:001

Firth Sterling, Inc. American Electro Metal Div.,
Yonkers, N. Y.

RESEARCH ON THERMIONIC EMISSION OF BORIDES,
by R. Steinitz. Final rept. May 1, 1957, 34p. incl. illus.
diagrs. tables, refs. (AFOSR-TN-57-312) (AF 18(600)-
1504) AD 132383 Unclassified

Thermionic emission measurements were performed on
most of the transition metal diborides, gadolinium hexa-
boride, and dense and porous tungsten cathodes. With
the exception of the dense tungsten, which was used to
standardize the test equipment, all samples were pre-
pared by powder metallurgical techniques. The neces-
sary vacuum system and electrical circuits were con-
structed to fit the requirements. The emission constant
and work function for each of the above metals has been
calculated from the emission data. However, in view of
the above discussion, the reliability of the data is ques-
tionable. A simple solution to most of these problems
has been planned for the future. Preliminary measure-
ments performed on a tungsten cathode with 26% porosity
showed a 32-fold improvement of emission over the
100% dense sample. This property was readily repro-
ducible in each of three independent runs. The values
for the thermionic emission of the transition metal di-
borides, which were obtained in this investigation, are
not accurate or reliable enough to try to correlate them
into the electronic structure of these materials or to
draw conclusions about the nature of the bond between
the boron and the metal atoms.

FLA.01:006

Florida State U. Dept. of Chemistry, Tallahassee.

SPIN-ORBITAL PERTURBATION IN CYANINE DYES
ADSORBED ON SURFACES CONTAINING HIGH-Z
ATOMS, by E. Clementi and M. Kasha. [1957] [2]p.
(AF 18(600)678) Unclassified

Published in Jour. Chem. Phys., v. 26: 956-957, Apr.
1957.

Strong spin-orbit perturbation of the emission spectrum
of dyes adsorbed on a PbBr₂ surface, and relatively

FLA.01:007 - FLA.01:010

little effect on SiO_2 and Al_2O_3 surfaces has been noted.

A considerable red shift of the order of a vibrational quantum has been observed in the triplet to singlet transition in the PbBr_2 system as compared to dyes included in EPA glass solvents. A brief study of adsorption on AgBr surfaces has also been carried out.

FLA.01:007

Florida State U. Dept. of Chemistry, Tallahassee.

FUNDAMENTAL ASPECTS OF PHOTSENSITIZATION. INTERCOMBINATIONS IN MOLECULES, by M. Kasha. June 15, 1958, 1v. incl. diagrs. tables, refs. (Technical rept. no. 2) (AFOSR-TN-58-477) (AF 18(600)678) AD 158288 Unclassified

This report contains the following published papers:

- (1) Solvent Effects on Merocyanine Spectra, by E. G. McRae (Spectrochim. Acta, v. 12: 192-210, Sept. 1958);
- (2) Intramolecular Twisting Effects in Substituted Benzenes. I. Electronic Spectra, by E. G. McRae and L. Goodman (Jour. Molecular Spectroscopy, v. 2: 464-493, Oct. 1958);
- (3) Intramolecular Twisting Effects in Substituted Benzenes. II. Ground State Properties, by E. G. McRae and L. Goodman (Jour. Chem. Phys., v. 29: 334-336, Aug. 1958); and
- (4) Energy Transfer in Molecular Complexes of Sym-Trinitrobenzene with Polyacenes. I. General Considerations, by S. P. McGlynn and J. D. Boggus (Jour. Amer. Chem. Soc., v. 80: 5096-5101, Oct. 5, 1958).

FLA.01:008

Florida State U. Dept. of Chemistry, Tallahassee.

FUNDAMENTAL ASPECTS OF PHOTSENSITIZATION. INTERCOMBINATIONS IN MOLECULES. SPIN-ORBITAL COUPLING IN ATOMS AND MOLECULES, by I. G. Ross. July 20, 1958, 69p. incl. diagr. (Technical rept. no. 3) (AFOSR-TN-58-603) (AF 18(600)678) AD 162128 Unclassified

The first half of this paper deals with the theory of spin-orbital coupling in atoms, and is largely a restatement of some relevant parts of Condon and Shortley: "The Theory of Atomic Spectra". The theory of spin-orbital coupling in molecules is in its infancy, but a most important question concerns the selection rules for mixing of states due to this interaction. This topic is dealt with at sufficient length so that the reader may have a better understanding of the way in which the multiplicity classification of molecular state wave function is broken down. Finally, a brief account is given of the few quantitative treatments of molecular spin-orbital interaction that have so far been published.

FLA.01:009

Florida State U. Dept. of Chemistry, Tallahassee.

SPIN ORBITAL INTERACTION IN N-HETEROCYCLIC MOLECULES: GENERAL RESULTS IN A CYLINDRICAL POTENTIAL APPROXIMATION, by E. Clementi and M. Kasha. [1958] [10]p. incl. tables, refs. (AF 18(600)-678) Unclassified

Published in Jour. Molecular Spectroscopy, v. 2: 297-307, June 1958.

The method for calculation of spin-orbital interaction in benzene, developed by Mizushima and Koide, is extended to N-heterocyclic molecules in which both (π, π^*) states are excited. Using the L.C.A.O.-M.O. approximation, the general matrix elements of the interaction are expanded to matrix elements involving A.O.'s. The cylindrical form of the potential used by Mizushima and Koide, and one-center integrals only, are adopted as approximations. The method is applied to the case of pyridine, and evaluation of the matrix elements is carried out on the basis of symmetry considerations. The net result is a prediction that the absolute value for the transition probability of the lowest triplet (n, π^*) - singlet transition in pyridine would be of the same order of magnitude as the transition probability of the analogous $\pi - \pi^*$ transition. Analysis of the results in terms of f-number ratios, and comparison with a parallel study based on a spherical potential, confirm a proposal of enhancement of spin-orbital interaction for (n, π^*) states. (Contractor's abstract)

FLA.01:010

Florida State U. Dept. of Chemistry, Tallahassee.

INTRAMOLECULAR TWISTING EFFECTS IN SUBSTITUTED BENZENES. II. GROUND-STATE PROPERTIES, by E. G. McRae and L. Goodman. [1958] [13]p. incl. diagrs. tables. (Bound with its AFOSR-TN-58-477; AD 158288) [AF 18(600)678] Unclassified

Also published in Jour. Chem. Phys., v. 29: 334-336, Aug. 1958.

The effects on ground-state properties of twisting a substituent-ring bond in substituted benzenes are discussed from the viewpoint of semiempirical MO theory. The ground-state properties are discussed with reference to a parameter θ , which generally increases as the substituent is twisted. The substituent-ring bond order varies approximately as $\cos \theta$, and the following vary approximately as $\cos^2 \theta$: the resonance energy, charge densities, ring C-C bond orders and the π -electronic dipole moment. The θ dependence of the total dipole moment is discussed. Numerical applications to N,N-dimethylaniline and related molecules are described, including a detailed treatment of the dipole moments of N,N-dimethylaniline and some of its orthosubstituted

FLA.01:011 - FLA.01:013

derivatives. A brief discussion of the valence state of the dimethylamino group is included. (Contractor's abstract)

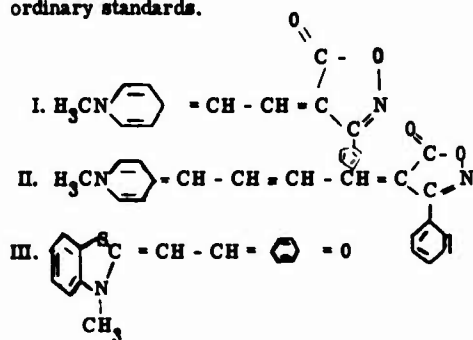
FLA.01:011

Florida State U. Dept. of Chemistry, Tallahassee.

SOLVENT EFFECTS ON MEROCYANINE SPECTRA, by E. G. McRae. [1958] [39]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TN-58-477; AD 158288) [AF 18-(600)678] Unclassified

Also published in *Spectrochimica Acta*, v. 12: 192-210, Sept. 1958.

Solvent effects on the visible absorption spectra of three merocyanine dyes are described. The dyes comprise two (I and II) of exceedingly high polarity, and a third (III) less polar than I and II but still highly polar by ordinary standards.



The absorption curves, values of the extinction coefficient and frequency at the absorption maxima (ϵ_{max} and ν_{max} respectively) and oscillator strengths are given for I dissolved in pure solvents, and for dyes II and III in a variety of both pure and mixed solvents. For each dye, ϵ_{max} and ν_{max} undergo pronounced solvent effects, but the oscillator strengths are insensitive to solvent perturbations. The results are discussed in terms of a simple theory in which the combining states are considered as superpositions of a polar and a non-polar resonance structure. A more detailed theory is applied in the interpretation of the frequency shifts induced by non-hydrogen bonding solvents. (Contractor's abstract)

FLA.01:012

Florida State U. Dept. of Chemistry, Tallahassee.

ENERGY TRANSFER IN MOLECULAR COMPLEXES OF SYM-TRINITROBENZENE WITH POLYACENES. I. GENERAL CONSIDERATIONS, by S. P. McGlynn and J. D. Boggus. [1958] [32]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TN-58-477; AD 158288) [AF 18(600)678] Unclassified

Also published in *Jour. Amer. Chem. Soc.*, v. 80: 5096-5101, Oct. 5, 1958.

The emission spectra of π -complexes of aromatics with sym-trinitrobenzene have been studied. It is shown that after irradiation in the charge-transfer band, two emissions occur: one the reverse of the charge-transfer absorption, the other from a triplet level of the uncomplexed aromatic. Absorption spectra of complexes, their total emission spectra and delayed emissions are described. Theoretical considerations of the processes involved lead us to presume that after excitation in the charge-transfer band, some intersystem crossing occurs to a dissociative triplet level of the complex. The resultant production of uncomplexed aromatic in its lowest triplet state then gives rise to the observed phosphorescence. State correlation diagrams and plots of ionization potential of aromatic versus the energy of the charge-transfer absorption are also described. (Contractor's abstract)

FLA.01:013

Florida State U. Dept. of Chemistry, Tallahassee.

INTRAMOLECULAR TWISTING EFFECTS IN SUBSTITUTED BENZENES. I. ELECTRONIC SPECTRA, by E. G. McRae and L. Goodman. [1958] [56]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TN-58-477; AD 158288) [AF 18(600)678] unclassified

Also published in *Jour. Molecular Spectroscopy*, v. 2: 464-493, Oct. 1958.

The electronic spectral effects of twisting a substituent group about the substituent-ring bond in substituted benzenes are analyzed from the viewpoint of semi-empirical MO theory including zeroth and first order configuration interaction. The substituent orbital ϕ_s^0 is expressed as a linear combination of two functions, ϕ_x and ϕ_y , which are respectively anti-symmetric and symmetric with respect to reflection in the ring plane: $\phi_s^0 = \cos \theta \phi_x + \sin \theta \phi_y$. Transition energies and intensities are discussed with reference to the twisting parameter θ . Ordinarily, θ increases as the substituent is twisted, and can be evaluated explicitly when the molecular geometry is known. The treatment is carried through both with and without cognizance of the nearest-neighbor overlap integrals, and the inductive effect of the substituent is discussed. Particular attention is given to the question of self-consistency. The theory applies especially to those transitions which correspond to transitions observed in the spectrum of benzene ("benzene-analogue" transitions). Three possible types of θ -dependence of transition energies are distinguished, and the conditions under which each might be realized are specified. Of the four benzene-analogue singlet-singlet transitions considered, the two of lowest energy

FLA.02:001-004; FLU.02:001, 002

are ordinarily predicted to suffer a decrease of intensity as θ increases, while the intensities of the remaining two transitions are predicted to be insensitive to twisting perturbations. "Charge transfer" transitions are also considered, though in less detail. The theory is applied in a detailed discussion of the ultraviolet absorption spectra of N,N-dimethylaniline and related molecules in which the dimethylamino substituent is twisted as a result of ortho substitution or intramolecular bridge formation. (Contractor's abstract)

FLA.02:001

Florida State U. Dept. of Physics, Tallahassee.

PRECISION STUDIES OF X-RAY ATTENUATION COEFFICIENTS. I. DESIGN OF THE EXPERIMENT, by R. D. Deslattes. 1958, 18p. (Technical rept. no. 1) (AFOSR-TN-57-425) (AF 18(603)64) AD 136414
Unclassified

The meaning of an x-ray attenuation coefficient is considered from the point of view of an experimental determination of its value. Consideration is given to the factors which affect the precision of its measurement including (1) those arising from the absorbers, (2) those arising from the x-ray spectrometer's resolution in energy, and (3) those arising from the detection of the x-ray beam. (Contractor's abstract)

FLA.02:002

Florida State U. Dept. of Physics, Tallahassee.

A MODERATELY VERSATILE PROGRAM CIRCUIT FOR COUNTING EXPERIMENTS, by R. D. Deslattes and D. L. Clemmons, Jr. 1958 [13]p. incl. diagrs. (Technical rept. no. 3) (AFOSR-TN-58-601) (AF 18(603)64) AD 162126
Unclassified

A device is discussed which was designed to execute various measurements in absorption and emission spectroscopy utilizing a two-crystal x-ray spectrometer. Its versatility is such, however, as to suggest applications to counting experiments in general. Its design is open, so that sequential procedures of arbitrary complexity may be executed by means of simple extensions of the circuitry. (Contractor's abstract)

FLA.02:003

Florida State U. Dept. of Physics, Tallahassee.

AN EXPERIMENTAL STUDY OF X-RAY ATTENUATION COEFFICIENTS, 8-30 kev, by R. D. Deslattes. Final rept. 1958, 1v. incl. diagrs. tables, refs. (AFOSR-TN-58-784) (AF 18(603)64) AD 202009; PB 138270
Unclassified

Precise values for the total attenuation coefficients were obtained at approximately 1 kv intervals from 8 to 30 kv for 15 pure elements using a two-crystal spectrometer of high resolving power. These span the range of atomic numbers from 12 to 79. (Possibly disturbing effects of small-angle scattering were investigated.) The resulting values of μ for some elements may be assigned an average standard deviation of 0.2%. (Contractor's abstract)

FLA.02:004

Florida State U. [Dept. of Physics] Tallahassee.

NUMBER OF 3d ELECTRONS IN THE TRANSITION METALS, by R. D. Deslattes. [1958] [1]p. [AF 18(603)-64]
Unclassified

Published in Phys. Rev., v. 110: 1471, June 15, 1958.

Values have been presented for the number of 3d electrons in Cu, Ni, Co, Fe, and Cr, in the solid state as obtained from absolute measurements of the scattering factor for x-rays. The work of Nilsson (Arkiv Fysik, v. 6: 513 (1953)), which favors conventional 3d electron configuration assignments to the atoms in the metals is compared with that of Weiss and DeMarco (Rev. Modern Phys., v. 30: 59 (1958))

FLU.02:001

Florida U. Dept. of Chemistry, Gainesville.

THE FORMATION OF LINEAR POLYMERS FROM DIENE MONOMERS BY A CYCLIC POLYMERIZATION MECHANISM. I. THE STRUCTURE OF POLY-(DIALLYLAMMONIUM HALIDES), by G. B. Butler, A. Crawshaw, and W. L. Miller. Jan. 17, 1958, 17p. (AFOSR-TN-58-42) (AF 18(603)116) AD 148083
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 3615-3618, July 20, 1958.

Two of the soluble, linear polymers obtained from monomers of the general formula $[(CH_2 = CHCH_2)_2NR_2]^+ Br^-$ have been degraded by well-known methods. Both mono-(diallylammonium bromide) and poly-(diallyldimethylammonium bromide) have given products resulting from the cleavage of piperidinium bromide rings present in the structures. The results confirm the structure previously proposed for these polymers. (Contractor's abstract)

FLU.02:002

Florida U. Dept. of Chemistry, Gainesville.

THE FORMATION OF LINEAR POLYMERS FROM

FOD.01:001, 002; FOR.01:002

DIENE MONOMERS BY A CYCLIC POLYMERIZATION MECHANISM. II. POLYACRYLIC ANHYDRIDE AND THE DERIVED POLYACRYLIC ACID, by A. Crawshaw and G. B. Butler. Dec. 1958 [3]p. Incl. diagrs. tables. (AFOSR-TN-58-479) (AF 18(603)116) AD 158290
Unclassified

Presented at meeting of the Polymer Chem. Div. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 1958.

Also published in Jour. Amer. Chem. Soc., v. 80: 5464-5466, Oct. 20, 1958.

The polymerization of acrylic anhydride in solution has been accomplished to yield a series of saturated linear polymers with molecular weight up to 95,000. The polymerization occurred through the means of alternating intramolecular-intermolecular mechanism and has led to a poly-3(5)-methyleneglutaric anhydride structure. The polyacrylic acid obtained by hydrolysis has been shown by means of its degree of crystallinity to have a more regular structure than normal polyacrylic acid. (Contractor's abstract, modified)

FOD.01:001

Fordham U. Dept. of Chemistry, New York.

PREPARATION OF ETHYL GLYOXYLATE BY OXIDATION OF ETHYL BROMOACETATE WITH DIMETHYL SULPHOXIDE, by I. M. Hunsberger and J. M. Tien. [1958] [2]p. (AFOSR-TN-58-530) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(603)127 and Public Health Service) AD 158345
Unclassified

Presented at meeting of the Amer. Chem. Soc., Chicago, Ill., Sept. 11, 1958.

Also published in Chem. and Indus. (London), No. 3: 88-89, Jan. 17, 1959.

Me_2SO (I) (3 vols) oxidizes 1 vol $\text{BrCH}_2\text{CO}_2\text{Et}$ (II) to OCHCO_2Et in 70% yield. Me_2S (III) formed may react with (II) to give $(\text{Me}_2\text{SCH}_2\text{CO}_2\text{Et})\text{Br}$ (IV), and there may be Me exchange between III and IV. I may also react with the HBr formed to give III, water, and Br. Addition of MeBr and 1,2-epoxy-3-phenoxypropane represses these side-reactions. Also prepared by this reaction are AcCO_2Et from $\text{MeCHBrCO}_2\text{Et}$ and $\text{CO}(\text{CO}_2\text{Et})_2$ from $\text{CHBr}(\text{CO}_2\text{Et})_2$. The ease of oxidation of $\text{RR}'\text{CHX}$ increases when X is varied from Cl to Br and I, and when R and R' are electron attracting. Although an induction period is observed, radical scavengers are ineffective, and the reaction is thought to proceed by a polar mechanism through an intermediate, $(\text{Me}_2\text{SOCHRR}')\text{X}$, which collapses to III, HX, and $\text{RR}'\text{CO}$.

FOD.01:002

Fordham U. Dept. of Chemistry, New York.

ELECTRON SPIN RESONANCE STUDIES OF PHOTOCHROMIC SOLIDS, by H. S. Gutowsky, R. L. Rutledge, and I. M. Hunsberger. [1958] [2]p. Incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)127, Office of Naval Research, and Public Health Service) AD 158345
Unclassified

Published in Jour. Chem. Phys., v. 29: 1183-1184, Nov. 1958.

Electron resonance studies were made of tetrachloro-1-oxonaphthalene (the structure of this compound is either 2,3,4,4-tetrachloro-1(4H)-naphthalenone or 2,2,3,4-tetrachloro-1(2H)-naphthalenone), N-(3-pyridyl) sydnone, the anils of salicylaldehyde with p-bromoaniline and 2-naphthylamine, and 2-(2,4-dinitrobenzyl) pyridine. In only the sydnone was an electron spin resonance detected. On exposure to a Hg vapor lamp, the white crystals turned blue. A detectable spin resonance absorption was detected later with an intensity depending on the temperature of the sample and the presence or absence of air. In evacuated samples no resonance was detected at room temperature until air was admitted. The blue color faded to a yellow green while the absorption increased and reached a maximum. The sydnone provides long-term storage of photochemical energy in a form readily available for chemical reaction.

FOR.01:002

Forest Products Lab., Madison, Wis.

A FUNDAMENTAL INVESTIGATION OF ADHESION. II. A METHOD FOR MEASURING SHRINKAGE STRESS IN RESTRAINED GELATIN FILMS, by R. C. Weatherwax, B. Coleman, and H. Tarkow. [Mar. 28, 1957] [18]p. Incl. diagrs. table. (AFOSR-TN-57-137) [CSO-670-55-27] AD 120494
Unclassified

Also published in Jour. Polymer Science, v. 27: 59-66, Jan. 1958.

Gelatin solutions shrink as water evaporates from the gel. If the shrinkage is prevented, tensile stresses develop. A technique is described for measuring the tensile stress developing in the plane of edge-clamped gelatin films during drying. It is based on measurement of the elastic deformation of the film when stressed normally to the plane of the film. At 50% relative humidity, stresses of 4,000 to 5,000 lb/sq in. were observed in several films. The reality of these stresses was confirmed by a completely independent method.

FPS.01:001; FPS.02:001;
FRA.01:004, 005

FPS.01:001

Forschungsinstitut für Physik der Strahlantriebe,
Stuttgart (Germany).

THE THERMODYNAMIC PROPERTIES OF HYDROGEN
AND WATER AS POSSIBLE WORKING FLUIDS FOR
NUCLEAR ROCKETS, by I. Singer-Bredt. Final rept.
May 1958, 58p. incl. diagrs. tables, refs. (AFOSR-TR-
58-87) (AF 61(514)910) AD 162108 Unclassified

The following topics are discussed: Notion and function
of a working fluid in rocket power planes; The heating
of hydrogen, respectively water, at constant pressure
and under equilibrium conditions, as well as attainable
flow velocities in the end of the expansion nozzle; First
comparative analysis of other possible working fluids,
particularly of hydrogen compounds of light elements;
Heat transfers of hydrogen, water, and helium, to the
interior walls of the combustion chamber under equi-
librium conditions; and The influence of nonequilibrium
processes on the values of exhaust velocities and heat
transfer, as well as on the qualification of the different
working fluids.

FPS.02:001

Forschungsinstitut für Physik der Strahlantriebe,
Stuttgart (Germany).

IRREVERSIBLE STOCHASTIC THERMODYNAMICS AND
THE TRANSPORT PHENOMENA IN A REACTING
PLASMA, by H. J. Kaeppler and G. Baumann. Final
rept. Nov. 1956, 104p. incl. diagrs. tables, refs.
(AFOSR-TR-57-20) (AF 61(514)939) AD 120462;
PB 150688 Unclassified

The investigations presented in this report are a first
venture in attempting a theory of transport phenomena
in a reacting plasma at elevated and high temperatures.
As an essential basis for such studies, the equilibrium
behavior of a plasma is treated. These equilibrium
considerations concern the influence of electrostatic
microfields on plasma properties, termination of the
electronic partition function, and determination of the
plasma composition. Entering into the problem of
energy transport, the classical diffusion theory of
transport is discussed. Then, an attempt is made at
establishing the rudiments of a stochastic description
of plasma physics, the thermodynamics of transport phe-
nomena in particular. It is shown that the theory in-
cludes the purely statistical methods. For the calcula-
tion of internal energy transport, the formal kinetic
theory due to Wang-Chang and Uhlenbeck is extended,
and approximate methods for integration of the collision
integrals are derived. Finally the energy transport in
the presence of chemical reactions is treated. (Con-
tractor's abstract)

FRA.01:004

Franklin Inst. Bartol Research Foundation, Swarthmore,
Pa.

INELASTIC PROTON SCATTERING FROM PHOS-
PHORUS, by D. M. Van Patter, C. P. Swann and others.
[1956] [1]p. [AF 18(600)1320] Unclassified

Presented at Internat'l. Conf. on Nuclear Reactions,
Amsterdam (Netherlands), July 2-7, 1956.

Published in Physica, v. 22: 1125-1126, Nov. 1956.

Using a 180° double-focusing magnetic spectrometer,
the inelastic proton spectrum from zinc phosphide
targets bombarded by 3.055 mev protons has been ob-
served at 90°. For a region of excitation from 0 to 1.42
mev, only one inelastic proton group was observed,
corresponding to a level in ^{31}P at 1.264 ± 0.004 mev.
No other inelastic groups were observed with an in-
tensity greater than 15% of the intensity of this group.
By the use of higher bombarding energies, of 3.12 and
4.65 mev, this survey has been extended to 3.55 mev ex-
citation. Three additional inelastic groups have been
observed, corresponding to ^{31}P levels at 2.23, 3.13 and
3.29 (± 0.01) mev. In the region from 0 to 1.26 mev ex-
citation, no inelastic groups were observed with an in-
tensity greater than a few percent of the first excited
state group. In addition, inelastic groups corresponding
to the first excited state of ^{64}Zn , ^{66}Zn and ^{68}Zn were
observed, corresponding to level energies of 0.99, 1.04
and 1.08 (± 0.01) mev, respectively.

FRA.01:005

Franklin Inst. Bartol Research Foundation, Swarthmore,
Pa.

INELASTIC PROTON SCATTERING FROM PHOSPHO-
RUS AND ZINC, by D. M. Van Patter, M. A. Rothman
and others. [1957] [15]p. incl. diagrs. table, refs.
[AF 18(600)1320] Unclassified

Presented at meeting of the Amer. Phys. Soc., New
York, Jan. 30-Feb. 2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II,
v. 2: 60, Jan. 30, 1957.

Also published in Phys. Rev., v. 107: 171-175, July 1,
1957.

Inelastic proton spectra from targets containing phospho-
rus and zinc have been studied at bombarding energies
of 3.72 and 4.66 mev using a double-focusing spectrom-
eter. Proton groups have been observed corresponding
to levels in ^{31}P at 1.264 ± 0.004 , 2.230 ± 0.005 ,

FRA.01:006 - FRA.01:008

3.134 ± 0.006 , and 3.292 ± 0.005 mev. Excitation curves for these four inelastic groups measured in the region of $E_p = 4.55$ to 4.70 mev show the same general resonant structure, although differing in detail. At $E_p = 4.66$ mev, no additional groups from P^{31} were observed for the excitation region 0 to 1.26 mev with an intensity greater than 2% of the intensity of the first excited state group. Four inelastic proton groups were observed from zinc. From a comparison with the known level schemes of the zinc isotopes, three of these groups were assigned to the following isotopes:

Zn^{64} , 0.991 ± 0.005 mev; Zn^{66} , 1.038 ± 0.005 mev; and Zn^{68} , 1.078 ± 0.005 mev. The remaining group with $Q = -1.802 \pm 0.005$ mev remains unassigned. (Contractor's abstract)

FRA.01:006

Franklin Inst. Bartol Research Foundation, Swarthmore, Pa.

Q-VALUE MEASUREMENTS FOR ALUMINUM AND CHLORINE, by D. M. Van Patter, W. C. Porter, and M. A. Rothman. [1957] [16]p. incl. tables, refs. [AF 18(600)1320] Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 143, Mar. 21, 1957.

Also published in Phys. Rev., v. 106: 1016-1019, June 1, 1957.

Nuclear reaction energies have been measured using a 180° double-focusing magnetic spectrometer. In order to test the reliability of the energy calibration of the spectrometer, 2 $Al^{27}(p,\alpha)Mg^{24}$ groups were observed, with measured Q-values of 1.596 ± 0.006 and 0.230 ± 0.005 mev, corresponding to the ground state of Mg^{24} , and the first excited state at 1.366 ± 0.006 mev. A further check was provided by the observation of 6 $Al^{27}(p,p')Al^{27}$ inelastic groups, corresponding to Al^{27} levels at 0.842 ± 0.003 , 1.013 ± 0.003 , 2.205 ± 0.004 , 2.727 ± 0.004 , 2.975 ± 0.004 , and 2.998 ± 0.004 mev. In view of the good agreement of these results with previous measurements, the ground-state Q-values of the $Cl^{35}(p,\alpha)S^{32}$ and $Cl^{37}(p,\alpha)S^{34}$ reactions have been re-measured as 1.860 ± 0.005 and 3.028 ± 0.006 mev, respectively. (Contractor's abstract)

FRA.01:007

Franklin Inst. Bartol Research Foundation, Swarthmore, Pa.

NUCLEAR DISINTEGRATION ENERGIES. II., by D. M. Van Patter and W. Whaling. [1957] [10]p. incl. tables, refs. [AF 18(600)1320] Unclassified

Published in Rev. Modern Phys., v. 29: 757-766, Oct. 1957.

This paper contains new measurements of nuclear reaction energies available to the authors up to Feb. 1, 1957. In addition, any measured values listed in the original compilation (Rev. Modern Phys., v. 26: 402-443, Oct. 1954) which have been revised or reassigned since its publication have been included.

FRA.01:008

Franklin Inst. Bartol Research Foundation, Swarthmore, Pa.

LEVELS IN Cr^{50} , Cr^{52} , Cr^{53} , AND Cr^{54} , by W. C. Porter, D. M. Van Patter and others. [1958] [7]p. incl. diagrs. tables, refs. [AF 18(600)1320] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 38, Jan. 29, 1958.

Also published in Phys. Rev., v. 112: 468-474, Oct. 15, 1958.

Inelastically scattered proton spectra from targets of natural chromium and targets enriched in Cr^{50} , Cr^{53} , and Cr^{54} have been studied for bombarding energies in the region of 4.3 to 4.6 mev using a double-focusing magnetic spectrometer, at angles of observation of 91.5° and 136.2° . The enriched targets were prepared by the vacuum evaporation of Cr_2O_3 from a small carbon crucible mounted on a tungsten filament onto gold-leaf backings. Surveys were taken up to at least 2.0 -mev excitation. The following level energies in kev were determined: Cr^{50} , 780 ± 3 ; Cr^{52} , 1432 ± 5 ; Cr^{53} , 562 ± 3 , 1006 ± 4 , and 1287 ± 5 ; Cr^{54} , 842 ± 6 . The new level in Cr^{50} occurs at the energy expected for the first $2+$ state. Inelastically scattered proton groups corresponding to the known second excited states of Cr^{52} and Cr^{54} were not sufficient intensity to be observed. (Contractor's abstract)

FRA.01:009, 010; FRA.05:003

FRA.01:009

Franklin Inst. Bartol Research Foundation, Swarthmore, Pa.

ENERGY AND SPIN SYSTEMATICS OF EVEN-EVEN NUCLEI WITH $22 \leq N < 50$ (Abstract), by D. M. Van Patter. [1958] [1]p. [AF 18(600)1320] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 212, May 1, 1958.

Recently, new information regarding the energy levels of even-even nuclei has become available, indicating that the energy ratio E_2/E_1 of the second to first excited state drops below 2 in the region $30 \leq N \leq 40$, as has been pointed out. Examination of the evidence concerning the energies and spins of the second and third excited states of nuclei in the region $22 \leq N < 50$ has revealed a possible systematic trend for the spin of the second excited state. For nuclei with $22 \leq N < 30$, the spin of the second excited state is always 4+ when measured. For nuclei with $32 \leq N < 50$, the spin of the second excited state is always 2+ when measured, omitting the low-lying 0+ states in Ge^{70} and Ge^{72} . There is some indication that the 4+ and 2+ levels may cross over at $N = 30$ to 32. Some implications of these possible systematic trends will be discussed.

FRA.01:010

Franklin Inst. Bartol Research Foundation, Swarthmore, Pa.

PROPOSED SYSTEMATICS FOR E2 TRANSITION PROBABILITIES OF EVEN-EVEN NUCLEI, by D. M. Van Patter. [1958] [3]p. [AF 18(600)1320] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago U., Ill., Nov. 26-29, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 360, Nov. 28, 1958.

Also published in Jour. Franklin Inst., v. 266: 411-413, Nov. 1958.

A survey has been made of all available data concerning lifetime determinations and Coulomb excitation cross sections for the first two 2+ levels of even-even nuclei. A pronounced correlation has been found between the reduced transition probability for decay, $B(E2)$, and the energy E_1 (in mev) of the first excited state. One way of demonstrating this correlation is to consider the quantity $B(E2)/Z^2$. For nuclei with $A = 46-132$, the

reduced transition probability for decay can be well represented (to about ± 25 percent) by $B(E2)/Z^2 = 2.2 \times 10^{-5} E_1^{-1.4}$ (in units of $e^2 \times 10^{-48} \text{ cm}^4$). For nuclei with $A = 146-202$, a similar expression is obtained: $B(E2)/Z^2 = 0.9 \times 10^{-5} E_1^{-1.3}$. However, it should be pointed out that this apparent correlation is not unique, for similar correlations between the favored factor F , or $FA^{5/3}/Z^2$, and E_1 can be demonstrated. Another interesting feature has been noticed for isotopes of W, Os, and Pt. The measured values of $B(E2)$ and the E2 transition between the second and first 2+ levels are consistent with the second expression given above.

FRA.05:003

Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.

FURTHER CONSIDERATIONS ON THE DUCTILITY OF IRON AT 4.2°K, by R. L. Smith and J. L. Rutherford. [1957] [2]p. incl. diag. (AF 18(600)1581) Unclassified

Published in Acta Metallurgica, v. 5: 761-762, Dec. 1957.

In a recent letter to the editor, Basinski and Slewyk showed three tensile curves for Ferrovac iron tested at 4.2°K. Each of these curves was for a different grain size. The authors observed that there was always a number of constrictions in the specimen-corresponding to the no. of serrations in the stress-strain curve. Smith and Rutherford have tested a large no. of iron specimens at 4.2°K and have found no correlation between the no. of constrictions and the no. of serrations. These authors believe that the heat generated by plastic deformation causes a localized decrease in strength during deformation due to the very low heat capacity together with the large temperature dependence of the yield stress at these temperatures. Their explanation for serrations seems unreasonable since one can obtain the same serrated curve for iron tested in tension at -196°C. Smith, Spangler and Brick found that the ductility in tension at low temperatures was determined by the grain size. The authors apparently overlooked the fact that ductility was greater for the specimen nearest the purest end of the zone-refined iron, even though the grain size was much larger than that at the impure end. It is important to note that at no time have Smith and Rutherford drawn any conclusions on the general ductility of very pure iron (as inferred by Basinski and Slewyk). They have only concluded that iron is not brittle in simple tension. To date, their results on zone-purified iron have always shown that it still has less ductility at 4.2°K, as measured by uniform strain in tension, than it does at higher temperatures.

FRA.05:004, 005; FRA.06:001, 002;
FRA.07:001

FRA.05:004

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

CELLULAR SUBSTRUCTURE IN Zn CRYSTALS GROWN
FROM THE MELT, by V. Damiano and M. Herman.
[1958] [2]p. incl. illus. diags. (AFOSR-TN-58-34)
[AF 18(600)1581] AD 148073 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 215:
136-137, Feb. 1959.

Examination of Zn single crystals containing Cd 0.05%,
grown at the rate of 10 cm/hr with a temperature
gradient of 15°C/cm produced evidence of the effect of
crystal orientation on some aspects of cellular growth
and of the degeneracy of these cells into dislocation
arrays.

FRA.05:005

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

EVIDENCE OF DISLOCATION LOOPS AND SPIRALS
IN ZINC, by V. Damiano and M. Herman. [July 1958]
7p. (AF 18(600)1581) Unclassified

Crystals of pure zinc and zinc alloyed with small
amounts of cadmium were cleaved, etched, and examined
under the light microscope. The loops and spirals ob-
served appear as configurations predicted by Frank
and Read. They proposed that a dislocation pinned at
its end may bow out and generate a continuous spiral;
and that if the dislocation is pinned at both ends, it
will collapse upon itself and generate closed disloca-
tion loops. It is concluded that the observed etch pat-
terns revealed on zinc represent dislocations in the
metal.

FRA.06:001

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

MAGNETIC EXAMINATION OF THE INITIAL PRECIPIT-
TATION IN A GOLD-NICKEL ALLOY, by A. E.
Berkowitz and P. J. Flanders. May 1957 [28]p. incl.
diags. tables, refs. (Interim technical rept. no. 1-
A2026-1) (AFOSR-TN-57-314) (Sponsored jointly by
Office of Naval Research and Air Force Office of Scien-
tific Research under AF 49(638)159) AD 132385
Unclassified

Magnetic measurements of gold-nickel alloy in the
initial stages of precipitation have been analyzed in
terms of the structure and growth behavior of the nickel-
rich precipitate, and the mechanisms of magnetization
of these particles. The magnetic measurements include

the field and temperature dependence of the saturation
magnetization, torque, rotational hysteresis, and
remanence. The structural properties of the precipitate
particles derived from these measurements are shape
and size distributions, degree of precipitation, coherency,
and orientation. After 206 min at 400°C when approxi-
mately one percent of the equilibrium precipitate had
developed, the particles were randomly oriented, not
coherent, and of the order of 1,000Å. The nearly spheri-
cal particles grew relatively rapidly and were magne-
tized by a non-uniform process. The more acicular
precipitate particles could be described by a uniform
magnetization process. The temperature dependence of
the magnetic properties also reflected the shape de-
pendence of the mechanism of magnetization. (Contractor's abstract)

FRA.06:002

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

MAGNETIC MEASUREMENTS ON SOME PRECIPITAT-
ING SYSTEMS, by A. E. Berkowitz and P. J. Flanders.
[1958] [3]p. [AF 49(638)159] Unclassified

Published in Jour. Appl. Phys., v. 29: 314-316, Mar.
1958.

In the systems Au-Ni and β -brass-Fe, ferromagnetic
precipitate particles develop in a nonmagnetic matrix.
Single crystal samples of these alloys have been exam-
ined by measuring saturation magnetization, torque
curves, rotational hysteresis, and remanence. The data
on the Au-Ni system have been analyzed to infer particle
anisotropy distributions, orientation of the "easy" axes
of the particles, and other features of the precipitate
particle system. Electron micrographs of the precipi-
tate particles are in general agreement with this analy-
sis. The measurements on the β -brass-Fe system
indicated that the precipitate particles were single crys-
tals with the same crystal habit as the matrix, and were
elongated in the $\langle 111 \rangle$ directions. The temperature de-
pendence of the torque curves was identified with the
temperature dependence of shape and magnetocrystalline
anisotropy. (Contractor's abstract)

FRA.07:001

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

COMPARISON BETWEEN NEGATIVE CARBON
REPLICAS AND SILICON MONOXIDE REPLICAS
(Abstract), by I. G. Greenfield and H. G. [F.] Wilsdorf.
[1957] [1]p. [AF 49(638)162] Unclassified

Presented at annual meeting of the Electron Microscope
Soc. Amer., Massachusetts Inst. of Tech., Cambridge,
Sept. 9-11, 1957.

Published in Jour. Appl. Phys., v. 28: 1375, Nov. 1957.

Negative carbon and silicon monoxide replicas are considered to be almost suitable for high resolution work. Since resolution measurements are known for silicon monoxide replicas but not for carbon replicas, a comparison between the two replica methods appeared to be desirable. In order to prevent the occasional ejection of carbon particles, the generally used carbon source was slightly modified. Carbon and silica replicas were taken from metals and inorganic crystals, and their properties determined. This includes a comparison of those properties which are imperative for high resolution, for instance, surface migration and inherent structure, as well as the properties important for handling of the replicas and for special purposes. A discussion of the merits of the two replica methods will be given.

FRA.07:002

Franklin Inst. [Labs. for Research and Development]
Philadelphia, Pa.

THE "DECORATION" OF DISLOCATIONS IN α -BRASS,
by R. Sun and H. G. F. Wilsdorf. [1958] [3]p. incl. illus.
[AF 49(638)162] Unclassified

Published in Jour. Franklin Inst., v. 265: 413-415,
May 1958.

It has been known for several years that dislocations can be "decorated" by impurity atoms. This is usually done by adding a predetermined quantity of impurities in solid solution, straining, and then heat treating. In metals, two processes are then possible: (1) the diffusion of impurity atoms to the dislocations, producing the so-called "atmospheres", and (2) the nucleating of precipitates at dislocation sites. Through subsequent etching, the atmospheres or the precipitates, and thereby the dislocations, can be revealed with the use of an electron microscope. This technique was used to decorate dislocations in Cd doped α -brass crystals. Observation of a single crystal which had been elongated 4% revealed that its surface was covered with etch pits which were immediately interpreted in terms of dislocations. They were arranged in rows, parallel to the active slip planes and appeared in distinct groups. Observation and measurement of the isolated dislocation pile ups occurring in slip lines offered proof that etch pits indeed mark dislocation sites, and that the theoretical calculations applying elasticity theory are well founded. Further, the data were in good agreement with the theoretical concept that dislocations form pile-ups against obstacles in the course of plastic deformation.

FRA.07:003

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

DISLOCATION PATTERNS IN DEFORMED ALPHA-BRASS, by H. G. F. Wilsdorf. [1958] [4]p. incl. illus.
[AF 49(638)162] Unclassified

Published in Proc. Symposium on Internal Stresses and Fatigue in Metals, Detroit and Warren, Mich. (Sept. 4-5, 1958), Amsterdam, Elsevier Publishing Co., 1959, p. 178-181.

The mechanism of plastic deformation in Cd-doped α -brass crystals was investigated. The dislocation patterns were observed with the use of an electron microscope. The comparison of distances between dislocations in a discrete pile-up with theoretical values yielded the result that there is a 1:1 correspondence between etch pits and dislocations. Counting the number of dislocations in these deformed regions, a dislocation density in the order

of $\rho = 4 \cdot 10^8 \text{ cm}^{-2}$ was found. The micrographs also showed that the pile-ups were headed in one direction mainly, indicating an excess of dislocations of one sign in any one area. A direct determination was made of n , the average number of dislocations in each group, and σ , the average number of groups per unit area. These values together with data obtained previously; namely s , the average glide for a slip line, and d , the average distance between slip lines, made it possible to calculate the average length of the path of a dislocation l , the average distance between dislocation groups, a , and the number of groups per slip line, N_{gr} . The following values were obtained: $l = 80\mu$; $a = 13\mu$; and average $N_{gr} = 23.3$. The experimental results were in excellent agreement with predictions made by Kuhlmann.

FRA.07:004

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

SURFACE STRUCTURE OF THERMALLY ETCHED SILVER (Abstract), by I. G. Greenfield. [1958] [1]p.
[AF 49(638)162] Unclassified

Presented at meeting of the Electron Microscope Soc. Amer., Santa Monica, Calif., Aug. 7-9, 1958.

Published in Jour. Appl. Phys., v. 29: 1625, Nov. 1958.

The crystallographic faces that appeared on thermally etched silver are in general low index faces of the type $\{111\}$ and $\{100\}$. Electron micrographs indicated that the perfection of these planes depended on the temperature, length of time of thermal etching, and the orientation of the lattice with respect to the surface of the specimen. Rod-like structures which were aligned parallel to each other appeared on the surfaces of some of the specimens.

FRA.08:001; FRE.04:001-004

FRA.08:001

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

A BIBLIOGRAPHY ON GAS-LUBRICATED BEARINGS,
by E. B. Sciulli. Dec. 1, 1957, 80p. (Interim rept. no.
I-A2049-1) (Sponsored jointly by Office of Naval Re-
search and Air Force Office of Scientific Research
under Nonr-234200) AD 147733 Unclassified

This partially annotated bibliography of 124 references on gas-lubricated bearings was compiled in an effort "to evaluate the present state of the art and to establish a library of available technical papers to serve as ready references of work done in this field." Foreign, e.g., British, French, German, and Japanese, as well as domestic, literature sources have been reviewed. Though most of the references are from open literature, i.e., books, technical journals, patents, a few report references are included, and some theses are cited. The entries range in time from 1828 through 1957. The following indexes are included: personal author index; subject index; "composite index" (consisting of a series of columns arranged so that most of the pertinent information concerning a reference will appear on one horizontal line); year of publication; and corporate author index. Appendixes contain additional references, associated-subject references, and notes of interest in the field of gas-lubricated bearings.

FRE.04:001

Free U. of Brussels (Belgium).

[ON THE MOLECULAR THEORY OF BROWNIAN
MOTION] Sur la theorie moleculaire du mouvement
Brownien, by I. Prigogine and R. Balescu. [1957]
[14]p. Incl. refs. (AFOSR-TN-58-101) (AF 61(514)957)
AD 148150 Unclassified

Also published in *Physica*, v. 23: 555-568, June 1957.

The theory of Brownian motion for weakly coupled systems has been derived from first principles for systems in which it is possible to trace the development of a single degree of freedom which is out of equilibrium. Two cases are studied in detail: (1) weakly coupled oscillators as are found in the theory of slightly anharmonic solids or in radiation theory; and (2) gases interacting through weak long-range forces such as gravitational or electrostatic forces. The first case is solved completely but not the second. The approach to equilibrium of the system is found to be governed by non-Gaussian Markoff processes.

FRE.04:002

Free U. of Brussels (Belgium).

ON IRREVERSIBLE PROCESSES IN NON-UNIFORM

SYSTEMS, by I. Prigogine and J. Philippot. [1958] [16]p.
(AFOSR-TN-58-247) (AF 61(514)957) AD 154149

Unclassified

Also published in *Physica*, v. 23: 569-584, June 1957.

The irreversible phenomena in inhomogeneous systems are studied. In the classical approach there remains a basic dissymmetry between evolution in the geometric space (reversible flow) and in energy space (irreversible collisions). The new terms derived in this paper introduce a complete symmetry into the problem. Both the motion in angle-spaces and in action space are governed by irreversible equations. Brownian motion is described here as a non-Gaussian Markoffian process which may be reduced to Kramer's equation for Brownian motion. An appendix is included which gives characteristic times and thermal conductivity of solids in relation to their thermodynamic properties. A very simple and explicit formula of thermal conductivity is given.

FRE.04:003

Free U. of Brussels (Belgium).

CONTRIBUTION TO THE THEORY OF ELECTRO-
DIFFUSION, by T. A. Bak and W. G. Kauman. [1958]
[2]p. (AFOSR-TN-58-647) (AF 61(514)957)
AD 162179 Unclassified

Also published in *Jour. Chm. Phys.*, v. 28: 509-510,
Mar. 1958.

A solution to the electrodiffusion equation has been given for constant and alternating applied fields for the total concentration of two species. It is shown that ordinary diffusion and electrodiffusion are not asymptotically independent as previously held.

FRE.04:004

Free U. of Brussels (Belgium).

[THEORETICAL STUDY OF A SYSTEM CONTAINING
AN AMPHOTERIC PRODUCT IN THE PRESENCE OF
pH GRADIENTS AND OF AN ELECTRICAL POTENTIAL]
Étude theorique d'un système contenant un produit
amphotérique en présence de gradients de pH et de
potentiel électrique, by W. G. Kauman. 1957, 1v. Incl.
diagrams, tables, refs. (AFOSR-TN-58-648) (AF 61-
(514)957) Unclassified

The distribution of an ampholyte is calculated for the stationary state when it is simultaneously in the presence of pH gradients and an electric potential. It is shown that in the case where the gradients act in opposite directions, the ampholyte will be strongly concentrated in the vicinity of the region where the pH of the solution corresponds to the isoelectric point. The intensity of this concentration increases if one or both of the two

FRE.04:005 - FRE.04:009

gradients are increased. Several numerical examples are given. The approach to the stationary state resulting from an initial arbitrary distribution is calculated and it is shown that the relaxation time for this approach is of the order of several minutes.

an oscillator immersed in a thermostat is considered in detail. (Contractor's abstract, modified)

FRE.04:007

Free U. of Brussels (Belgium).

SHAPE OF SPOT AND RATE OF SORPTION IN PAPER CHROMATOGRAPHY, by W. G. Kauman and T. A. Bak. [1958] [2]p. [AF 61(514)957] Unclassified

Published in Nature, v. 182: 743-744, Sept. 13, 1958.

A theory is advanced and mathematically considered which provides a value for the rate of advancement of the spot and explains its shape. By comparing the 2 axes of the elliptical spot at different velocities, values for rate constants, for adsorption and for desorption can be deduced.

FRE.04:008

Free U. of Brussels (Belgium).

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON TRANSPORT PROCESSES IN STATISTICAL MECHANICS, BRUSSELS, Aug. 27-31, 1956, ed. by I. Prigogine. N. Y., Interscience Publishers, Inc., 1958, 436p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Internat'l. Union of Pure and Applied Physics, Instituts Solvay, and Air Force Office of Scientific Research under [AF 61(514)957]) Unclassified

The theme of the meeting was the extension of statistical mechanics to the transport phenomena class of non-equilibrium systems. Considerable reference is made to the domain of irreversible thermodynamics, but it is examined critically only from the statistical viewpoint. Forty-eight papers are presented showing recent trends in both theoretical and experimental research.

FRE.04:009

Free U. of Brussels (Belgium).

STATISTICAL MECHANICAL FOUNDATIONS OF THE BOLTZMANN EQUATION, by R. Brout. [1958] [4]p. [AF 61(514)957] Unclassified

Published in Proc. Internat'l. Symposium on Transport Processes in Statistical Mechanics, Brussels (Belgium) (Aug. 27-31, 1956), N. Y., Interscience Publishers, Inc., 1958, p. 15-18.

An investigation is presented of the conditions under which an irreversible transport equation in the velocity space for N molecules for macroscopically homogeneous systems reduces to the Boltzmann equation.

FRE.04:005

Free U. of Brussels (Belgium).

ON THE ELECTROPHORETIC SEPARATION OF AMPHOLYTES IN A MEDIUM OF NON-UNIFORM pH, by W. G. Kauman. [1957] [15]p. incl. diagrs. table. (AFOSR-TN-58-651) (AF 61(514)957) AD 162183 Unclassified

Also published in Bull. Acad. Roy. de Belgique, Cl. Sci., Series 5, v. 43: 854-868, Dec. 7, 1957.

The behavior of amphoteric electrolytes under the combined action of a gradient of pH and air electrostatic potential is investigated theoretically. It is shown that ampholytes may be separated and concentrated if the positive electrode is placed on the acid side of the pH gradient. Results are presented which show that under these conditions, the distribution of the ampholyte at the stationary state will vary approximately as a Gaussian error function of distance with the maximum at the isoelectric point. The "Bandwidth" of the maximum is found to depend inversely on the magnitudes of the gradients. The relaxation time for the approach to the stationary state is calculated and found to be of the order of a few minutes. (Contractor's abstract)

FRE.04:006

Free U. of Brussels (Belgium).

ON IRREVERSIBLE PROCESSES IN QUANTUM MECHANICS, by I. Prigogine and M. Toda. [1958] [15]p. (AFOSR-TN-58-652) [AF 61(514)957] AD 162184 Unclassified

Also published in Molecular Phys., v. 1: 48-62, Jan. 1958.

A general theory of irreversible processes in weakly coupled systems based on classical mechanics has been extended to the study of quantum mechanical systems. In this procedure the density matrix is divided into a slowly varying and an oscillatory part, and asymptotic equations are established for the matrix elements. In the representation in which the unperturbed Hamiltonian is diagonal, these equations take a particularly simple form for weakly coupled systems in which the matrix elements lying on diagonal parallel to the principal diagonal undergo separate transformations. A particular case is that in which the diagonal elements are transformed to yield the Pauli equations. As an illustrative example the problem of the frictional forces on

FRE.04:010-012; FRE.03:004

FRE.04:010

Free U. of Brussels (Belgium).

IRREVERSIBLE PROCESSES IN WEAKLY COUPLED SYSTEMS, by I. Prigogine and R. Brout. [1958] [8]p. [AF 61(514)957] Unclassified

Published in Proc. Internat'l. Symposium on Transport Processes in Statistical Mechanics, Brussels (Belgium) (Aug. 27-31, 1958), N. Y., Interscience Publishers, Inc., 1958, p. 25-33.

The classical statistical mechanics of irreversible processes in weakly coupled multiply periodic systems are discussed in terms of the spectral decomposition of the density distribution in phase space.

FRE.04:011

Free U. of Brussels (Belgium).

GRAVITATIONAL FORCES AND DYNAMIC FRICTION, by R. Balescu. [1958] [4]p. [AF 61(514)957] Unclassified

Published in Proc. Internat'l. Symposium on Transport Processes in Statistical Mechanics, Brussels (Belgium) (Aug. 27-31, 1958), N. Y., Interscience Publishers, Inc., 1958, p. 33-38.

Irreversible processes are studied by a master equation derived by Brout and Prigogine for classical weakly coupled systems. The application is to the gases of point stars with long-range interactions between the particles. As a result of the interactions, it is shown that any incident star will be systematically decelerated in the direction of its motion, a phenomenon described as dynamic friction which is evaluated by the quantity

$\frac{dv_0}{dt}$. The Hamiltonian of the isolated global cluster is used to develop the master equation:

$$\frac{\partial \mathcal{E}}{\partial t} = \frac{A}{\gamma} \sum_{i < j} \int dk \frac{1}{k} k \left(\frac{\partial}{\partial v_i} - \frac{\partial}{\partial v_j} \right) \delta[k \cdot (v_i - v_j)] k \cdot \left(\frac{\partial}{\partial v_i} - \frac{\partial}{\partial v_j} \right) \mathcal{E}$$

with $A = 2G^2 m^2$ and v = volume of the system. The situation is analyzed for the limiting situations of the divergence for $k \rightarrow 0$ and $k \rightarrow \infty$. The upper cutoff for $k \rightarrow 0$ is placed approximately equal to $k_D = 1/R_0$ and

$$\text{for } k \rightarrow \infty, \text{ one obtains } \frac{dv_0}{dt} = - \int dv_0 \phi(v_0) \eta(v_0) v_0 =$$

$-\overline{\eta(v_0)} v_0$, exhibiting the coefficient of dynamic friction

$$\eta(v_0) = 16\pi^2 n A \ln q v_0^{-2} \cdot \frac{1}{v_0^3} \int_0^v dv v^2 f(v).$$

FRE.04:012

Free U. of Brussels (Belgium).

CYCLIC PROCESSES IN IRREVERSIBLE THERMODYNAMICS, by I. Prigogine and R. Balescu. [1958] [3]p. [AF 61(514)957] Unclassified

Published in Proc. Internat'l. Symposium on Transport Processes in Statistical Mechanics, Brussels (Belgium) (Aug. 27-31, 1958), N. Y., Interscience Publishers, Inc., 1958, p. 343-345.

Cyclic rotation processes around a stationary state are considered from a thermodynamic standpoint. A variational principle is postulated for Glansdorff and Prigogine's theorem: The total differential of the entropy production P is written as $dP = d_X P + d_V P$, with $d_X P = \sum V_i dX_i$ and $d_V P = \sum X_i dV_i$ (V_i , X_i are rates and affinities of the irreversible processes). Along every path followed by the system during its evolution, $d_X P \leq 0$, for time-independent boundary conditions. The value 0 corresponds to the stationary state. From Volterra's model using the analysis of two coexisting mutually predatory biological species A and B, $d_X P/dt = (B - \epsilon_1) \dot{A} + (\epsilon_2 - A) \dot{B} = -\nu \leq 0$, which is comparable to imposing a sense of rotation around the stationary state. This provides a means of studying $d_X P$ as a variational principle, in spite of its non-integrability as a general case.

FRE.03:004

Free U. of Brussels. Lab. of Molecular Chemistry and Physics (Belgium).

A MASS SPECTROMETRIC METHOD FOR THE DETERMINATION OF DISSOCIATION ENERGIES OF DIATOMIC MOLECULES, by J. Drowart and R. E. Honig. [1957] [16]p. incl. diagrs. tables, refs. (AF 61(514)868) Unclassified

Published in Jour. Phys. Chem., v. 61: 980-985, July 1957.

By combining experimental data obtained in a mass spectrometer with thermochemical computations, dissociation energies of various diatomic molecules have been determined. This method has been applied to the Group IB and IVB dimers, and estimates have yielded values for Group IIIB and some other elements. To produce atomic and diatomic species of a given element, a milligram sample was vaporized in a mass spectrometer from a small, electrically-heated crucible. Ion intensity ratios were measured as a function of temperature, after the particles had been ionized, accelerated, mass analyzed, and collected. The dissociation energies computed by the Absolute Entropy Method are based on the

FRE.03:005 - FRE.03:008

following quantities: ion intensity ratios; internuclear distances, estimated from known crystal spacings; electronic partition functions; and vibrational frequencies reported recently in band spectral studies. The values found agree well with those obtained by the so-called Slope Method which utilizes directly the measured heats of vaporization of monomers and dimers, and they fall within the upper limits set by band spectral data. (Contractor's abstract)

FRE.03:005

Free U. of Brussels. Lab. of Molecular Chemistry and Physics (Belgium).

MASS SPECTROMETRIC STUDY OF THE MOLECULES Cu_2 , Ag_2 , AND Au_2 , by J. Drowart and R. E. Honig.

[1957] 2p. (AF 61(514)868) Unclassified

Published in Mem. Soc. Roy. Sci. Liège, v. 18: 536-537, 1957.

A mass spectroscopic study of the vapors of Cu, Ag, and Au give the following ratios: $\text{Cu}_2/\text{Cu} = 8 \times 10^{-4}$ at 1540°K; $\text{Ag}_2/\text{Ag} = 5 \times 10^{-4}$ at 1260°K; and $\text{Au}_2/\text{Au} = 7 \times 10^{-4}$ at 1600°K. From these ratios the following dissociation energies were calculated: $D_0(\text{Cu}_2) = 2.0_2 \text{ ev}$, $D_0(\text{Ag}_2) = 1.6_3 \text{ ev}$, $D_0(\text{Au}_2) = 2.18 \text{ ev}$.

FRE.03:006

Free U. of Brussels. Lab. of Molecular Chemistry and Physics (Belgium).

VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURE, by P. Goldfinger and J. Drowart. Final technical rept. Oct. 1957, 25p. incl. diags. tables, refs. (AFOSR-TR-58-5) (AF 61(514)868) AD 148038; PB 133279 Unclassified

Accurate thermodynamic data for the vaporization of elements and compounds were obtained by means of mass spectrometry. Molecular species as Cu_2 , Ag_2 , and Au_2 were found during an investigation of the vapor phase; the dissociation energies of the molecules were determined. No such molecules were observed in the vapor phase of the transition elements. Study of the vapor phase evaporating from the III-V compounds, GaAs and InP, yielded new data on the dissociation energies of the tetramer molecules of group V elements. The maximum of stability was observed for As_4 or Sb_4 .

The partial decomposition pressures of GaAs, InP, CdSe, and CdTe allowed the calculation of the heat of formation, the free energy of formation, and the standard entropy of these compounds, as well as the dissociation

energies of the molecules As_4 , P_4 , Sb_4 , Se_2 and Te_2 .

FRE.03:007

Free U. of Brussels. Lab. of Molecular Chemistry and Physics (Belgium).

MASS SPECTROMETRIC STUDIES OF THERMODYNAMIC PROPERTIES OF GROUP III-V AND II-VI COMPOUNDS AND GROUP V AND VI ELEMENTS, by P. Goldfinger and M. Jeunehomme. Sept. 1958, 24p. incl. diags. tables, refs. (AF 61(514)868) Unclassified

Presented at the Mass Spectrometry Conference, London (England), Sept. 24-26, 1958.

The mass spectrometric investigation of the evaporation of InAs, GaSb and ZnS enabled thermodynamic data regarding these substances to be obtained. The dissociation energies of tetramer to dimer of the Group V elements were found: $D(\text{As}_2-\text{As}_2) = 69.6 \text{ kcal/mol}$ and

$D(\text{Sb}_2-\text{Sb}_2) = 63.4 \text{ kcal/mol}$. These are in good agreement with the values obtained previously from the evaporation of GaAs and InSb. ZnS decomposes when heated near 1000°K, and Zn and S_2 evaporated in equivalent amounts; a lower limit $D(\text{S}_2) \geq 78 \text{ kcal/mol}$ was

calculated. The evaporation of gray Se was investigated and was found to contain at about 480°K some 10 percent molecules Se_8 and perhaps Se_7 .

FRE.03:008

Free U. of Brussels. Lab. of Molecular Chemistry and Physics (Belgium).

[THERMODYNAMIC STUDY OF GROUP III-V AND GROUP II-VI COMPOUNDS BY MASS SPECTROMETRY] Étude Thermodynamique des Composés III-V et II-VI par Spectrométrie de Masse, by J. Drowart and P. Goldfinger. [Apr. 4, 1958] [12]p. incl. diags. tables, refs. (AF 61(514)868) Unclassified

Published in Jour. de Chimie Physique, v. 55: 721-732, Oct. 1958.

Partial decomposition pressures were measured for the group III-V compounds GaAs, InP, and InSb and for the group II-VI compounds CdSe and CdTe. The latter made it possible to calculate the heat of formation, the free energy of formation, and the entropies as well as the dissociation energies. In contrast to methods employed in prior research, the apparatus was adapted so that the molecular rays traveled perpendicular to the ionic and electronic tubes rather than parallel. This prevented collision with the walls; it prevented formation of deposits, and it enabled the surfaces of the specimens to

FRU.01:001 - FRU.01:003

be under constant observation and their temperatures to be measured with precision.

FRU.01:001

Fribourg U. [Dept. of Physics] (Switzerland).

GAS-LIQUID SYSTEMS FOR USE IN A GAS BUBBLE CHAMBER, by B. Hahn and J. Fischer. [1957] [5]p. Incl. illus. (AFOSR-TN-57-427) [AF 61(514)1262] AD 136416 Unclassified

Also published in Rev. Scient. Instruments, v. 28: 656-657, Aug. 1957.

Several new liquids in combination with CO_2 were tried in a gas bubble chamber which is operated at room temperature. The chamber is filled with a liquid which is saturated under pressure with a gas. The gas-liquid system when expanded ionizes particles that give rise to gas bubble formation along their path. Propane, butane, pentane, isopentane, hexane, heptane, triethylamine, silicone 0.65 centistoke, and silicon 5.0 centistoke were used successfully with CO_2 . In order to determine the life of bubble nuclei the chamber was irradiated by a pulsed gamma ray source at various moments before beginning the expansion. Preliminary results for isopentane, hexane, and silicones put an upper limit to the life of bubble nuclei to about 100 μsec .

FRU.01:002

Fribourg U. [Dept. of Physics] (Switzerland).

GAS BUBBLE CHAMBER CHARACTERISTICS (Abstract), by B. Hahn and G. Riepe. [1957] [1]p. [AF 61-(514)1262] Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 380, Dec. 19, 1957.

An experimental gas bubble chamber, 4 cm in diameter

and 5 cm deep, has been investigated on its performance in the electron beam of a 32-mev betatron. For various gas-liquid systems the pressure variations inside the chamber during the expansion has been measured and gas bubble chamber characteristics as, e.g., sensitive time, bubble density, and rate of bubble growth have been studied. Optimum operation conditions will be discussed.

FRU.01:003

Fribourg U. [Dept. of Physics] (Switzerland).

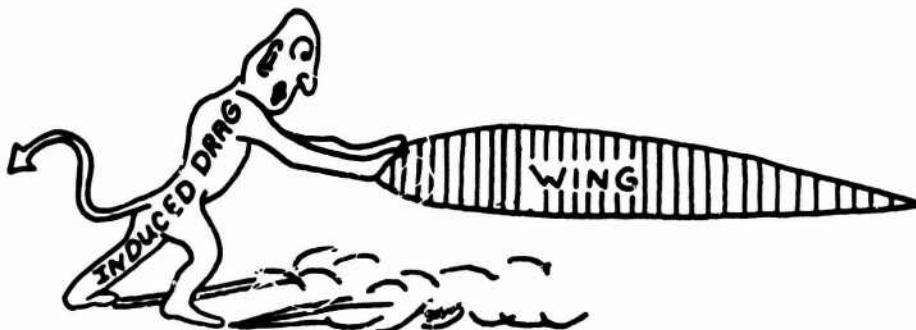
FLUOROCARBON GAS BUBBLE CHAMBER, by B. Hahn and G. Riepe. [1958] 4p. Incl. illus. table. (AFOSR-TN-58-8) (AF 61(514)1262) Unclassified

Also published in Rev. Scient. Instruments, v. 29: 184-185, Feb. 1958.

It is known that almost any chemically stable and transparent liquid will yield visible bubble tracks due to ionizing radiation when put under proper working conditions in a bubble chamber. An ethiforane (C_2F_6) - proforane (C_3F_8) gas-liquid system was operated successfully at room temperature in a "dirty" bubble chamber 4 cm in diam and 5 cm in depth. Bubble densities as high as 100 bubbles per cm were produced for minimum ionizing electrons upon heating the chamber to 29°C ($p_{\text{eq}} \sim 15 \text{ atm}$). From the experimental data available on several existing bubble chambers and the help of some theoretical arguments, the operating temperatures and pressures for some pure fluorocarbons in a "dirty" bubble chamber were estimated to be: C_3F_8 (43°C , 13 atm); C_4F_{10} (79°C , 11.5 atm); and C_5F_{12} (115°C , 10.5 atm). In addition to the fluorocarbons, sulfur hexafluoride (SF_6), certain freons (e.g., CClF_3), and some of the fluoroethers are suggested as attractive liquids for use in a gas bubble chamber.

Frick Chemical Lab., Princeton, N. J.

see Princeton U. Frick Chemical Lab., N. J.



GMH.01:001, 002; GEB.01:001, 002

Gates and Crellin Labs., Pasadena, Calif.
see California Inst. of Tech. Gates and Crellin Labs.,
Pasadena.

GMH.01:001

Gaustad Mental Hospital, Oslo (Norway).

RECORDING OF EMOTIONAL STRESS (Abstract), by C.
W. Sem-Jacobsen. [1957] [1]p. (AF 61(514)1201)

Unclassified

Presented at meeting of the Aeromedical Association,
Denver, Colo., May 6-8, 1957.

Published in Jour. Aviation Med., v. 28: 217-218, Apr.
1957.

Rapidly mounting emotional stress or sudden fear encountered by most people may in some instances leave the person "stiff" for a short period, during which he is not able to react or respond to outside stimuli in a rational way. It has long been a challenge to record these experiences with physiological equipment. In the course of intracerebral recordings, there were recorded short periods of flattening of the depth tracings, indicating a blocking of the brain activity in response to frightening of the patient by a sudden sharp noise. In a thoroughly examined non-epileptic patient, a buildup to a convulsive seizure was recorded in response to sudden mounting emotional stress. The findings are related to animal study and may be related to the sudden strange behavior of, for instance, tree surgeons treating tall, decayed trees. There has also been some speculation regarding the possibilities of extreme emotional stress or sudden fear, being responsible for some of the fatal crashes of low flying jet planes. Examples from unexplained jet crashes are presented.

GMH.01:002

[Gaustad Mental Hospital, Oslo (Norway).]

ELECTROENCEPHALOGRAPHIC RECORDING IN
SIMULATED COMBAT FLIGHT IN A JET FIGHTER
PLANE. THE PILOT'S LEVEL OF CONSCIOUSNESS,
by C. W. Sem-Jacobsen, O. Nilseng and others.
[1958] 2p. (Sponsored jointly by Air Force Office of
Scientific Research under [AF 61(514)1201] and Royal
Norwegian Air Force) Unclassified

Presented at AGARD meeting in Paris, France,
June 16-17, 1958.

Also published in EEG Clin. Neurophysiol., v. 11:
154-155, Feb. 1959.

In this aeromedical study, a standard 8-channel EEG
(electroencephalogram) transistor apparatus was modified and installed in a Royal Norwegian Air Force T33.

Operational flights showed that this apparatus tolerated an altitude of 20,000 ft, a temperature of 45°C, a force of 8 g's, and rolls and other flying maneuvers. In flight EEG recordings were made of pilots and backseat passengers. Though little data have been collected, they indicate that a pilot's level of consciousness during operational flight varies, and that these changes can be recorded using EEG methods.

GEB.01:001

[Gebelein, Hans, Bamberg (Germany).]

STATISTICAL STUDIES ON THE TURBULENT STATE
OF MOTION. PART I. KINEMATICS, by H. Gebelein
and E. Svenson. Mar. 1957, 42p. (Technical note no. 1)
(AFOSR-TN-57-278) (AF 61(514)925) AD 126539
Unclassified

In this report a new systematical account on some parts of the statistical theory of turbulence is presented. The main subject is the "correlation tensors" $\hat{R}(X(P), Y(P'))$ for two random quantities $X(P)$ and $Y(P')$ at two arbitrary control points P and P' . The quantities in question are the pressure, the local velocities with their dyadical products and their gradients, and the vorticity components. In order to present this analysis in a rational way, the common tensor calculus is completed for tensors up to the fourth order in strict analogy to vector calculus. The investigation starts with the classical case of homogenous and isotropic turbulence of an incompressible fluid. These three conditions are analyzed thoroughly and it is shown how the results change when the suppositions are lessened. Anisotropic but homogenous turbulence is treated in detail in strict analogy to the presentation of isotropic and homogenous turbulence with particular attention to the correlations of the velocity gradients and the vorticities.

GEB.01:002

[Gebelein, Hans, Bamberg (Germany).]

PROCEEDINGS OF THE MEETING ON TURBULENCE,
11-14TH OF MAY 1957 IN THE MATHEMATICAL RE-
SEARCH INSTITUTE AT OBERWOLFACH, ed. by H.
Gebelein. June 1957, 24p. (AFOSR-TN-57-529)
(AF 61(514)925) AD 136514; PB 135584 Unclassified

Abstracts of papers are presented on turbulence theory with discussions on its dynamics, the effects of viscosity, transition probabilities, and applications of statistical and symbolic tensor calculus to the theory. In the course of this conference, the main traits of the research work under contract have been discussed, and by comparison of the results with those from other theoretical approaches a valuable survey on the actual situation of turbulence research was obtained.

GEB.01:003; GDC.01:001;
GEN.02:001; GEN.03:001; GRC.01:001

GEB.01:003

Gebelein, Hans, Bamberg (Germany).

STATISTICAL STUDIES ON THE TURBULENT STATE OF MOTION. PART II. CONTRIBUTIONS TO DYNAMICS, by H. Gebelein and E. Svenson. Nov. 1957, 31p. incl. refs. (Technical note no. 2) (AFOSR-TN-58-45) (AF 61(514)925) AD 148085; PB 136189

Unclassified

Contributions to dynamics of turbulence are treated, and the relationship between the statistical concept of turbulent motion and the classical hydrodynamic equations is discussed. A systematical account is made of dynamical facts of homogeneous turbulence, and the problems of shear turbulence are treated.

GDC.01:001

General Dynamics Corp. General Atomic Div.,
San Diego, Calif.

FORMATION OF FREE RADICAL SOLIDS USING BEAM TECHNIQUES (Abstract), by W. L. Fite. [1958] [1]p. (AF 49(638)301)

Unclassified

Presented at Symposium on Unstable Chemical Species, Los Angeles, Calif., June 23-24, 1958.

Experiments now in progress are attempting to produce solids in which atomic hydrogen is stabilized at 4°K and below, by condensation of atomic beams. By using modulated atomic beam techniques so that sampling of the beam can be made through ionization and mass analysis, detailed knowledge of the relative fractions of various species striking the condensing surface is ensured. In addition, these techniques, along with usual stagnation detection of the beam, promise to allow study of various processes of importance in the condensation process, e.g., thermal accommodation coefficient, sticking coefficient, and probability of reassociation of the atoms into molecules. A discussion is presented of the experimental approach as well as early results of these experiments.

General Electric Co., Schenectady, N. Y.

DISLOCATIONS AND MECHANICAL PROPERTIES OF CRYSTALS; AN INTERNATIONAL CONFERENCE HELD AT LAKE PLACID, SEPTEMBER 6-8, 1956, ed. by J. C. Fisher, W. G. Johnston and others. New York, John Wiley and Sons, Inc., 1957, incl. illus. diagrs. tables, refs. (AFOSR-TR-58-3) (AF 18(603)101)

Unclassified

See item no. GEN.01:001.

GEN.02:001

General Electric Co., Schenectady, N. Y.

GROWTH AND PERFECTION OF CRYSTALS: PROCEEDINGS OF AN INTERNATIONAL CONFERENCE ON CRYSTAL GROWTH, Cooperstown, N. Y. (Aug. 27-29, 1958), ed. by R. H. Doremus, B. W. Roberts, and D. Turnbull. N. Y., Wiley and Sons, 1958, 609p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-157) (AF 49-638)258) AD 206571

Unclassified

This volume contains up-to-date and pertinent reports and discussions on crystal phenomena, polymer crystallization, and crystallization of simpler molecules. Organic, inorganic, and polymeric substances are investigated from the standpoint of crystal perfection, formation and structure of whiskers, presence of dislocations, and the mechanism of crystal growth from the melt, solution and vapor. Several reports emphasize the important differences and points of similarity between polymer and ordinary crystallization. Special features are presented which relate crystal growth in metals to that of growth in polymers and other types of solids; bring together literature on whisker phenomena dating back to 1574; summarize present understanding of crystal growth; and introduces the many advances made in the field since the Faraday Society Discussions of 1949.

GEN.03:001

General Electric Co. General Electric Research Lab.,
Schenectady, N. Y.

INTERNATIONAL CONFERENCE ON THE ELECTRONIC PROPERTIES OF METALS AT LOW TEMPERATURES, Hobart College, Geneva, N. Y., Aug. 25-29, 1958. [1958] 245p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)274], Office of Naval Research, National Science Foundation, and Internat'l. Union Pure and Appl. Phys.)

Unclassified

This conference contains papers on the following topics: (1) electronic structure; (2) superconductivity; (3) transport; (4) ultrasonic attenuation; (5) alloys; and (6) resonance. Sixteen papers are presented in layman's language. Summaries of each session are included, and brief discussions of some of the papers are presented.

GRC.01:001

General Research Co., Beverly Hills, Calif.

INVESTIGATION INTO THE NATURE OF SHORT RANGE NUCLEAR FORCES, by K. G. Foelsch. Mar. 15, 1957 [36]p. incl. diagrs. table. (Technical note - Phase 1; rept. no. 12555) (AFOSR-TN-57-145) (AF 18(603)88) AD 126434

Unclassified

See item no. GRC.01:002 for abstract.

GRC.01:002; GRC.02:001;
GNV.01:001; GEO.01:003, 004

GRC.01:002

General Research Co., Beverly Hills, Calif.

INVESTIGATION INTO THE NATURE OF SHORT RANGE NUCLEAR FORCES, by K. G. Foelisch. Aug. 30, 1957 [78]p. incl. diagrs. refs. (GRC rept. no. 83057) (AFOSR-TR-57-83) (AF 18(603)88) Unclassified

An attempt is made to simplify the physical picture of a nucleus by assuming that electrons and positrons, the elementary particles, are the building stones of the nucleon (proton and neutron). An exponential function of the distance is introduced with a linear coupling factor which is computed from the electrostatic charge of the elementary particle and its mass. By this function the character of the Coulomb Law in the nuclear field is substantially changed, thereby providing the possibility of obtaining electrostatic equilibrium between any number of electrons and positrons. This new idea is first applied to the dynamics of the mass point.

GRC.02:001

General Research Co., Beverly Hills, Calif.

TECHNOTICS; A STUDY OF EFFECTIVE COMMUNICATION OF TECHNICAL AND SCIENTIFIC KNOWLEDGE, by J. S. J. Hlobil. July 10, 1957, 34p. incl. diagrs. refs. (Rept. no. TEX-101) (AFOSR-TR-57-45) (AF 49(638)-174) AD 132473 Unclassified

Technotics, as proposed in the current study, is a systematic method of increasing the effectiveness of communication of technical and scientific knowledge by attenuation of noise in the communication channels. Noise in the communication channels is described as including any distracting element which prevents the preparation of a clear message, clear delivery of a message, and a clear reception of a message. For practical application, especially for decision-making meetings, use of TechnOrienta (a Technotics orientation chart) is advocated.

GNV.01:001

Geneva U. (Switzerland).

A RESEARCH STUDY IN STATISTICS: STATISTICAL FOUNDATIONS OF THERMODYNAMICS. APPLICATION OF THERMODYNAMICAL METHODS, IN COMMUNICATION THEORY AND IN ECONOMETRICS, by B. Mandelbrot. Final technical rept. 1956-1957, 31p. (AFOSR-TR-57-97) (AF 61(514)1209) AD 148011 Unclassified

Three types of problems were discussed. The problem of word statistics was resumed with main postulate being that all the different distinguishable sentences of given coding cost (and, in some cases, given number of

words) have equal probabilities. Results show that the number of words, of cost less than u , may be written as: $r(u) = V[\exp(b' u - b' C_0) - 1]$. The number V , which was

neglected by Shannon, is the inverse of the information per word and plays the role of the volume in the present thermodynamical theory. Several types of syntax were also considered. Results show that the formula

$p(r) = (B-1) V^{B-1} (r + V)^{-B}$ holds, whatever the syntax, as soon as the volume V and the temperature $1/B$ are large. A theory of the law of Pareto was presented. The main tool is the definition of the Pareto-Lévy variables and sequences. A theory of entropy and a theory of divisibility were added to the author's approach to the foundations of thermodynamics. (ASTIA abstract)

George Washington Carver Foundation, Tuskegee, Ala.
see Tuskegee Inst. George Washington Carver Foundation, Ala.

GEO.01:003

George Washington U. Washington, D. C.

BIO-PHYSICS IN EUROPE, by S. A. Talbot. Apr. 1957, 41p. (ARDC rept. no. TN-57-2) (AF 18(600)1180) AD 113006; PB 127880 Unclassified

The format of this report comprises Part I, the assembled results of interviews for each country visited, sometimes with an introduction describing special factors influencing the present status of biophysics there; Part II, discusses the information and viewpoints derived from each country; and Part III, presents a summary, critique, and evaluation of the research activities visited in Northern Europe. It is intended to provide the reader with a superficial idea of the scientific aspect of European biophysics. This author is from Johns Hopkins U., Baltimore, Md.

GEO.01:004

George Washington U., Washington, D. C.

PROCEEDINGS OF TRI-SERVICE CONFERENCE ON BIOLOGICAL HAZARDS OF MICROWAVE RADIATION, Rome Air Development Center, N. Y., July 15-16, 1957, by E. G. Pattishall. [1957] 121p. incl. diagrs. tables, refs. (AF 18(600)1180) Unclassified

Through a contract with George Washington University, Air Research and Development Command Headquarters has been advised on the microwave radiation hazards and research needs by a group of outstanding scientists of various disciplines. With the advent of the newly assumed Air Force responsibility for tri-service coordination, it became desirable to assemble the ARDC advisory panel, tri-service representatives, and various contractors working in the radiation hazard area to

GEO.02:003; GTU.01:001;
GIT.02:002; GIT.03:002

effect an understanding of activities and accomplishments to date. The papers presented represent the contributions of many leaders in the fields of biology, physics, and medicine. The agenda for the conference included the following presentations: the Air Force's new tri-service responsibility, a summary of the School of Aviation Medicine's research program on the biomedical aspects of microwave radiation, background data on the planned RADC program, the highpower facilities existing at RADC, plans for a radiation hazard research program at Rome Air Development Center, a summary of radiation hazards to ordnance, the exposure of Air Force personnel to ionizing radiation, physiological basis of RF-injury, data on laboratory animals exposed to microwaves, a summary on RF measurements, and a free discussion on related problems.

GEO.02:003

George Washington U. Dept. of Pharmacology,
Washington, D. C.

METABOLISM OF CYSTEAMINE, by R. A. Salvador, C. Davison, and P. K. Smith. [1957] [19]p. incl. diagrs. tables, refs. (AFOSR-TR-57-41) (Sponsored jointly by Atomic Energy Commission under AT(30-1)1107 and Air Force Office of Scientific Research under AF 18-(600)853) AD 132414 Unclassified

Inorganic sulfate, taurine, cysteamine and cystamine were demonstrated in the urine of normal and x-irradiated male mice receiving S^{35} -cysteamine. These findings corroborate reports of its degradation in rats. There appears to be no difference in the metabolism of this agent as a result of its presence during x-irradiation. Excretion of radioactivity, however, was significantly slower in the x-irradiated animal. In man, as in the mouse, sulfate and taurine constituted the largest portion of the urinary excretory products. Several metabolites present in human urine were not seen in mouse urine. In man, the urinary end products differed under hypoxic conditions. (Contractor's abstract)

GTU.01:001

[Georgetown U., Washington, D. C.]

A REVIEW OF FACTORS IN LEARNING EFFICIENCY, by R. M. Gage and R. C. Bolles. Nov. 1958, 30p. incl. refs. (In cooperation with Princeton U., N. J., and Pennsylvania U., Philadelphia) (AFOSR-TN-58-924) [AF 49(638)187] AD 162275; PB 137897 Unclassified

The main body of this report deals with principles derived from laboratory findings and theoretical writings that seem relevant to the problem of promoting efficient learning. References are usually made to a key paper, set of studies, or to an authoritative work summarizing the field. Consideration is given to the kind of evidence

which exists, the suggestions it has for learning efficiency, and its adequacy in dealing with this problem. Some conclusions are drawn regarding the present state of knowledge of these principles and the research questions which appear to be in need of investigation.

GIT.02:002

Georgia Inst. of Tech. Engineering Experiment Station,
Atlanta.

INFLUENCE COEFFICIENTS FOR CIRCULAR CYLINDRICAL SHELLS WITH LINEARLY VARYING WALL THICKNESS, by M. B. Sledd. Apr. 10, 1957, 22p. incl. diagrs. refs. (Rept. no. 2) (AFOSR-TN-57-196) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1459—continued by AF 18(600)-1462 at Lehigh U. Dept. of Physics, Bethlehem, Pa.—and Office of Naval Research) AD 126491 Unclassified

An analysis is presented of a thin-walled, elastic, right circular cylinder loaded on one edge with a uniformly distributed shearing force H_2 and a bending moment M_2 , and with the other edge free. For purposes of subsequent comparison, expressions are recorded for the influence coefficients of the shell with constant wall thickness and semi-infinite axial length, and for a shell with constant wall thickness and finite axis length. Consideration is then given to expressions for varying thickness, including the following: radial displacement, rotation, horizontal stress resultant, and bending moment—all as functions of axial distance. These expressions are used to obtain coefficients for a shell loaded along its thicker edge. The results are expressed in terms of Kelvin functions, and compared graphically with those previously recorded for shells of constant thickness.

GIT.03:002

Georgia Inst. of Tech. Engineering Experiment Station,
Atlanta.

MEASUREMENTS OF THE MOBILITIES OF THE NEGATIVE IONS IN OXYGEN AND IN MIXTURES OF OXYGEN WITH THE NOBLE GASES, HYDROGEN, NITROGEN, AND CARBON DIOXIDE, by E. W. McDaniel and H. R. Crane. [Sept. 1957] [6]p. incl. illus. diagrs. table, refs. (Reprint no. 122) (In cooperation with Michigan U., Ann Arbor) (AF 18(600)1524) Unclassified

Published in Rev. Scient. Instruments, v. 28: 684-689, Sept. 1957.

The mobility constants for oxygen negative ions in He, Ne, Ar, Kr, Xe, H_2 , N_2 , and CO_2 each containing various partial pressures of O_2 were measured, and extrapolations to zero partial pressure of O_2 were obtained. A

GIT.03:003, 004; GOT.02:001;
GOT.03:001, 002

measurement of the mobility of the negative ion in 100% oxygen was also made. The value found for the latter was $2.46 \pm 0.05 \text{ cm}^2/\text{v-sec}$ at STP. It was shown that the mobility values referred to a single species of oxygen ion, but the question as to whether it was O_2^- or O_3^- was not resolved. A time-of-flight method was used, in which the ions were made by the passage of alpha particles through the gas, and detected by a proportional counter. (Contractor's abstract)

GOT.02:001

[Göttingen U. Inst. of Physiology (Germany).]

[DEVELOPMENT OF OXIMETER], by K. Kramer, N. J. Nilsson and others. Apr. 7, 1955 [23]p. (AFOSR-TR-58-7) (In cooperation with Marburg U. (Germany)) (AF 61(514)427) AD 148050 Unclassified

The new oximeter described here utilizes the property of selenium cells to give logarithmic responses to change in light intensity when used in open circuits. Since the O_2 -saturation of the blood in the flushed ear is a logarithmic function of transmitted light it has been possible to obtain oximetric readings directly proportional to the O_2 -saturation. The linearity has been shown to hold within the entire range from 100 to 25% saturation. A method has been elaborated which enables individual calibrations of the ear pieces without blood sampling and chemical analyses. The accuracy is of the same order of magnitude as that of commonly used oximeters. Other new technical items are special arrangement and spectral sensitivity of photocells and a method for arresting blood flow to the examined ear area. (Contractor's abstract)

GIT.03:003

Georgia Inst. of Tech. Engineering Experiment Station, Atlanta.

THE LOW-FIELD MOBILITIES OF THE NEGATIVE IONS IN O_2 AND O_2 MIXTURES, SF_6 , SO_2 , AND HCl , by E. W. McDaniel. Jan. 10, 1958, 119p. incl. illus. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TN-58-332) (AF 18(600)1524) AD 154236

Unclassified

See item no. GIT.03:004 for abstract.

GIT.03:004

Georgia Inst. of Tech. Engineering Experiment Station, Atlanta.

LOW-FIELD MOBILITIES OF THE NEGATIVE IONS IN OXYGEN, SULFUR HEXAFLUORIDE, SULFUR DIOXIDE, AND HYDROGEN CHLORIDE, by E. W. McDaniel and M. R. C. McDowell. Nov. 15, 1958, 39p. incl. diagrs. tables, refs. (Technical rept. no. 2) (AFOSR-TN-58-909) (AF 18(600)1524) AD 204513; PB 140811

Unclassified

Also published in Phys. Rev., v. 114: 1028-1037, May 15, 1959.

Measurements of the low-field mobility of the negative ions in O_2 , SF_6 , SO_2 , and HCl are described. The results are 2.46, 0.57, 0.35, and $0.71 \text{ cm}^2/\text{v-sec}$, respectively, reduced to 0°C and 760 mm Hg pressure. A quantum-mechanical theory of ionic mobility is outlined and applied to the gases investigated experimentally. Comparison of the experimental and theoretical results indicates that the oxygen ion is O_3^- , but attempts to identify the ions in the other gases are inconclusive. (Contractor's abstract)

Giannini Research Lab., Santa Ana, Calif.
see Plasmadyne Corp. Giannini Research Lab., Santa Ana, Calif.

GOT.03:001

Göttingen U. [Inst. of Physiology] (Germany).

PHYSIOLOGICAL RESEARCH USING KRAMER OXIMETER, by K. Kramer. Final rept. Jan. 8, 1957, 14p. incl. illus. (AFOSR-TR-57-19) (AF 61(514)901) AD 120458 Unclassified

See AFOSR-TR-57-72 (item no. GOT.03:002) under this contract, for abstract and journal reference.

GOT.03:002

Göttingen U. Inst. of Physiology (Germany).

A WHOLE BLOOD COLORIMETER FOR CONTINUOUS RECORDING OF CONCENTRATION OF AN INFRARED ABSORBING DYE. ITS USE IN CARDIAC OUTPUT DETERMINATIONS, by K. Kramer and G. Ziegenrucker. [1957] [5]p. incl. illus. diagrs. table. (AFOSR-TR-57-72) (AF 61(514)901) AD 136621 Unclassified

Also published in Klin. Wochenschr., v. 35: 468-472, May 1, 1957.

A whole blood colorimeter for continuous recording of an infrared absorbing dye at the infrared isosbestic point of hemoglobin ($805\text{m}\mu$) has been constructed. It has the advantage over methods using dyes such as Evans blue and indigo carmin in that errors due to O_2 -saturation changes are avoided. Arterial dye concentration curves are presented after injections of 0.05 mg/kg

GOT.04:001

of the new substance. The dye, being a derivative of cyanine, is nontoxic in doses 10 times as high as used in an actual experiment. Controls of cardiac output in dogs with the rotameter have furnished comparable results. Mean deviation at normal range of cardiac output amounts to $\pm 5\%$. (Contractor's abstract)

GOT.04:001

Göttingen U. Inst. of Physiology (Germany).

EFFECT OF AUTONOMIC AFFERENT IMPULSES ON BRAINSTEM NEURONS, by R. von Baumgarten and K. Kramer. Final rept. Sept. 19, 1957, 17p. incl. illus. (AFOSR-TR-57-73) (AF 61(514)1265) AD 136622

Unclassified

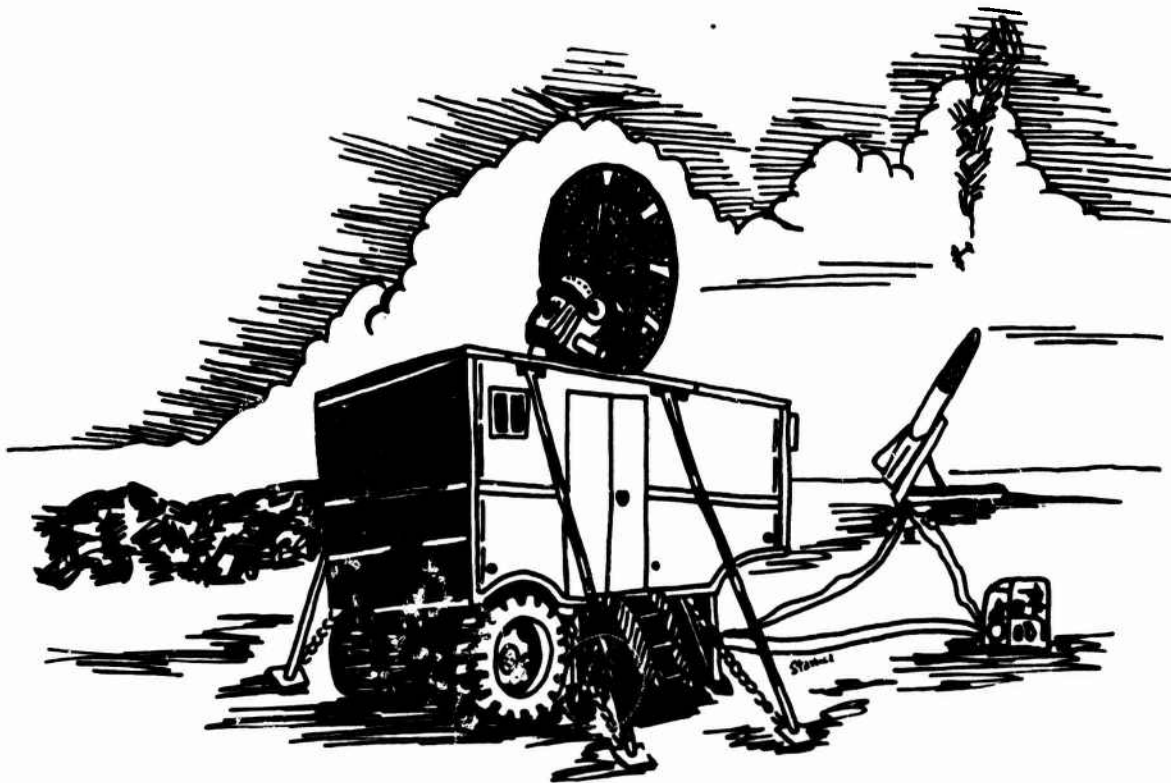
To take recordings of actions potentials of single units in the nucleus supra opticus the following preparatory studies were carried out: (1) Histological studies of the basal hypothalamic area revealed basal position and disk shaped form of the nucleus, its high vascularization and dense population of fairly great cells; (2) Several types of microelectrodes were tested. A modification of Hubels tungsten wire electrolytically sharpened

was found to be the electrode most suitable for our purpose. Insulation of electrode was obtained by quartz evaporation; (3) The subcortical approach to the nucleus supra opticus made necessary a modification of the classical stereotactic device; and (4) Examples of micro-electrode recordings in the nucleus supra opticus are shown. Local discharge patterns show pulsatory rhythms sometimes closely related to heart rate. In other cases rhythms are independent but under vagal control. (Contractor's abstract)

Guggenheim Aeronautical Lab., Pasadena, Calif.
see California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

Guggenheim Jet Propulsion Center, Pasadena, Calif.
see California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

Gustaf Werner Inst. of Nuclear Chemistry (Sweden)
see Uppsala U. Gustaf Werner Inst. of Nuclear Chemistry (Sweden).



HAM.03:001, 002; HAM.01:002;
HAM.02:005, 006

HAM.03:001

Hamburg U. (Germany).

ESTIMATIONS OF ERROR FOR NONLINEAR ELLIPTICAL DIFFERENTIAL EQUATIONS, by A. Meyer. Oct. 1956, 49p. incl. diagrs. tables. (AFOSR-TN-57-2) (AF 61(514)880) AD 115032 Unclassified

It is shown that for many nonlinear differential equations, the boundary value problem with an elliptical differential equation is of monotonous type and that, therefore, bounds can be obtained for its solution. The second boundary value problem is considered in addition to the first and third boundary problem. Formulas which allow the estimation of error are given and applied to some examples.

are constructed by Mehrstellen methods. A systematical examination is made of the corresponding Taylor expansions to find the appropriate finite equations. All formulas are tailored for quadratic grids; in numerical examples they are much more accurate. The first boundary problem is covered in 3-dimensional space. The finite expressions are generalized for inner points of a cubic net with Taylor balance up to h^5 ; for net points close to the boundary, a Taylor balance up to at least h^3 is obtained. The ordinary finite difference method, with Taylor balance up to h^2 , which substitutes
$$\frac{u(x-h,y,z) - 2u(x,y,z) + u(x+h,y,z)}{h^2} \text{ for } \frac{\partial^2 u}{\partial x^2}$$
 as a special case. Numerical examples for the formula are worked out.

HAM.03:002

[Hamburg U. (Germany).]

ESTIMATION OF ERROR FOR NONLINEAR ELLIPTICAL DIFFERENTIAL EQUATIONS, by A. Meyer. Final rept. July 1957, 72p. incl. diagrs. tables. (AFOSR-TR-57-57) (AF 61(514)880) AD 136512 Unclassified

Proof is given that for many nonlinear differential equations, the boundary value problem with an elliptical differential equation is monotonous, and bounds can be obtained for its solution. First, second, and third boundary-value problems are considered. Monotony theorems are presented for the case where the boundary conditions are nonlinear, or the domain considered is unbounded. Formulas are constructed to allow the estimation of error; examples are given for some cases. (Contractor's abstract)

HAM.02:005

Hamburg U. Inst. of Applied Mathematics (Germany).

A DIFFERENTIATION TECHNIQUE FOR PARTIAL DIFFERENTIAL EQUATIONS WITH NON-LINEAR BOUNDARIES, by J. Albrecht. Final technical rept. [1957] 1v. incl. diagrs. tables, refs. (AFOSR-TN-57-139) (AF 61(514)631-C) AD 120496; PB 136190 Unclassified

Finite difference methods for elliptic differential equations for domains with curved boundaries and for parabolic and hyperbolic differential equations are presented. A special Mehrstellen method is shown to be as accurate as usual Mehrstellen formulas.

HAM.01:002

[Hamburg U. (Germany).]

FINITE DIFFERENCE METHODS FOR BOUNDARY VALUE PROBLEMS OF PARTIAL ELLIPTIC DIFFERENTIAL EQUATIONS AND CURVED BOUNDARIES, by W. Uhlmann. Final rept. Mar. 1957, 129p. incl. diagrs. tables. (AFOSR-TR-57-46) (AF 61(514)881) AD 132431 Unclassified

Finite equations are obtained for the first, second and third boundary value problems of the differential equation $\Delta u(x,y) = r(x,y,u)$ and for the first boundary value problem of the differential equation $\Delta u(x,y,z) = r(x,y,z,u)$. Emphasis is put on boundary values for curved boundaries by forming finite expressions for Δu in the usual manner except that the quadratic, hexagonal, and octagonal stencils are not regular. Formulas

HAM.02:006

Hamburg U. Inst. of Applied Mathematics (Germany).

A DIFFERENTIATION TECHNIQUE FOR PARTIAL DIFFERENTIAL EQUATIONS WITH NON-LINEAR BOUNDARIES. [PART I] FINITE DIFFERENCE METHOD FOR ELLIPTIC DIFFERENTIAL EQUATIONS FOR DOMAINS WITH CURVED BOUNDARIES, by J. Albrecht. [1957] 33p. incl. diagrs. tables. ([Part I] of its AFOSR-TN-57-139; AD 120496) (AF 61(514)631-C) AD 120496(a) Unclassified

A finite difference method is used to numerically solve the boundary value problem for the general second order elliptic differential equation. Regular and irregular finite equations are used. The second and third boundary conditions are considered for domains with curved boundaries. A combination of the method of Schröder with the mechanised Gaussian algorithm is discussed.

HAM.02:007, 008; HAR.08:001, 002

HAM.02:007

Hamburg U. Inst. of Applied Mathematics (Germany).

A DIFFERENTIATION TECHNIQUE FOR PARTIAL DIFFERENTIAL EQUATIONS WITH NON-LINEAR BOUNDARIES. [PART II] THE FINITE DIFFERENCE METHOD FOR PARABOLIC AND HYPERBOLIC DIFFERENTIAL EQUATIONS, by J. Albrecht. [1957] [31]p. incl. diagrs. tables. ([Part II] of its AFOSR-TN-57-139; AD 120496) (AF 61(514)631-C) AD 120496(b)
Unclassified

Also published in Zeitschr. Angew. Math. Mech. (ZAMM), v. 37: 202-212, May/June 1957.

A discussion is presented of the method of finite differences as applied to parabolic and hyperbolic differential equations (heat conduction and bar vibration), concerning in particular: connection between stability, step size in time direction, and position of the lattice points used; accuracy ("Mehrstellen-method"); curved boundaries; and Runge-Kutta's principle. (Contractor's abstract, modified)

HAM.02:008

Hamburg U. Inst. of Applied Mathematics (Germany).

A DIFFERENTIATION TECHNIQUE FOR PARTIAL DIFFERENTIAL EQUATIONS WITH NON-LINEAR BOUNDARIES. [PART III] A SPECIAL MEHRSTELLEN METHOD, by J. Albrecht. [1957] [6]p. incl. diagrs. ([Part III] of its AFOSR-TN-57-139; AD 120496) (AF 61-514)631-C) AD 120496(c)
Unclassified

Numerov's idea of the method of "central differences" for initial value problems is generalized to the Mehrstellen method for ordinary and partial differential equations. A simplification of the usual Mehrstellen formulas is presented. The finite equations for $\Delta u = q + ru$ and the heat equation are given. Collatz's Mehrstellen formulas for $\Delta u + \lambda u = -$ are included.

Hamilton Coll., Ont. (Canada).

see McMaster U. Hamilton Coll., Ont. (Canada).

Hammond Metallurgical Lab., New Haven, Conn.

see Yale U. Hammond Metallurgical Lab., New Haven, Conn.

HAR.08:001

Harvard U. Cruft Lab., Cambridge, Mass.

INTERCONTINENTAL FREQUENCY COMPARISON BY VERY LOW-FREQUENCY RADIO TRANSMISSION, by J. A. Pierce. Feb. 15, 1957 [36]p. incl. illus. diagrs.

(Technical rept. no. 220) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186607)
AD 126051
Unclassified

Presented at Symposium on Propagation of Very-Low-Frequency Electromagnetic Waves, Boulder, Colo., Jan. 23-25, 1957.

Also published in Proc. Inst. Radio Engineers, v. 45: 794-803, June 1957.

Studies of signals from Rugby, England, at 16 kc/s and 60 kc/s have given evidence that a single source of standard frequency can be made available at VLF on a world-wide basis. At a distance of 5200 kilometers the doppler effects in transmission seldom exceed ± 3 parts in 10^9 , and a measurement can be made to 1 part in 10^9 in a few minutes. Accuracies exceeding 1 part in 10^{10} are consistently obtained by observation over several hours. Data contributed by Allan, Crombie, and Penton, of the New Zealand Dominion Physical Laboratory, indicate that at 16 kc/s the diurnal doppler effects at 18,700 km have normal maxima of the order of $1/10^8$, and that a measurement of 3 or 4 parts in 10^9 can be made in an hour or less. These results are described and some of the effects of solar flares and magnetic disturbances are discussed. In addition, a brief description is given of four mechanisms that have been found useful in comparing the frequency of a local oscillator with that of a VLF standard transmission. (Contractor's abstract)

HAR.08:002

Harvard U. Cruft Lab., Cambridge, Mass.

RECENT LONG-DISTANCE FREQUENCY COMPARISONS, by J. A. Pierce. Sept. 10, 1958, 7p. incl. illus. (Technical rept. no. 270) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186607)
Unclassified

Since March 1, 1958, a number of comparisons were made between the frequency of an Atomichron at Cruft Laboratory and the frequencies of other Atomichrons in Boulder and Washington. Comparisons were also made with the cesium resonator at the National Physical Laboratory at Teddington, England. A limited number of daily direct comparisons with Boulder had a standard deviation of 1.4 parts in 10^{11} . This value may be determined by the uncertainties of the phase of the LF transmission at 60 kc, or by changes in the Atomichrons. Comparisons with Washington and Teddington using a VLF carrier had a standard deviation of about $2/10^{10}$ that was apparently controlled by vagaries of the crystal oscillator at the transmitter. The vagaries of HF WWV transmission, even under the best conditions, limited

HAR.03:014 - HAR.03:015

the standard deviation at about $4/10^{10}$. It appears that the average frequencies of different Atomichrons, aligned and operated in different ways, may be in very close agreement or may differ by as much as 3 parts in 10^{10} . (Contractor's abstract)

with which to compare the experimental data that are presented in the companion report. (Contractor's abstract)

HAR.03:015

Harvard U. Cruft Lab., Cambridge, Mass.

HAR.03:014

Harvard U. Cruft Lab., Cambridge, Mass.

SIGNALS AND NOISE IN A FREQUENCY MODULATION RECEIVER. PART I. THEORETICAL DISCUSSION, by H. W. Fuller and D. Middleton. Feb. 1, 1957 [89]p. incl. diagrs. refs. (Technical rept. no. 242) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 129257 Unclassified

This report first reviews the theoretical description of the frequency modulation receiver available in the literature: in particular, the effect of the FM receiver on a received wave consisting of a signal and random noise. In Chapter II an abbreviated theoretical development of the FM receiver is presented, generally following the combined works of Middleton, and using the results obtained by Davenport for the output of an infinite limiter. The development assumes an idealized discriminator and normal random noise of the fluctuation type. The development features an arbitrary limiter dynamic characteristic (that is later specialized), a modulated carrier, an arbitrary signal-to-noise ratio, and arbitrary limiting. A closed-form expression for the total mean power output of the FM receiver is obtained, in the course of the presentation, for a receiver input of noise alone. Compact forms are found of the expressions for the output correlation function and spectrum in the case of a receiver input of noise along with arbitrary limiting. The results for arbitrary limiting are critically reviewed and appropriate modifications are made. Simple expressions for the infinite limiter output correlation function are obtained from Davenport's results for the cases of weak and strong carriers. In Chapter III a discussion of various IF filter characteristics is given and three specific characteristics are chosen for further consideration on the basis of experimental and analytical expediency. A further discussion of the modified results for the noise-alone arbitrary-limiting case is given, and the results are verified by a comparison between calculations made from two different expressions for the total mean power output. Expressions for the output correlation function and spectrum for the noise-alone arbitrary-limiting case are obtained using both synchronous-tuned double and rectangular IF filter characteristics. Output spectra of the infinite limiter are found for the gauss-shaped and synchronous-tuned double IF filter characteristics. A number of calculated curves are presented for the three chosen IF filter characteristics to supplement the extensive results given by Middleton for the gauss-shaped IF filter, and to furnish theoretical findings

SIGNALS AND NOISE IN A FREQUENCY MODULATION RECEIVER. PART II. EXPERIMENTAL DISCUSSION, by H. W. Fuller. Feb. 1, 1957, 1v. incl. illus. (Technical rept. no. 243) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 129258 Unclassified

The experimental methods and equipment are described in Chapter IV together with figures showing the performance of the individual units of the system. The more interesting circuit features of two analog multipliers, a negative feedback limiter, and a balanced modulator-type discriminator are discussed in detail. Reasons are listed for believing that the FM receiver output in some cases presents an unusually difficult measurement problem. Sample estimates are made of the errors encountered in experimental continuous spectrum analysis for spectra of the kind found at the output of an FM receiver. The accumulated experimental results are displayed and discussed in Chapter V. Sample waveforms simultaneously photographed at the limiter and receiver outputs for a variety of operational conditions are interpreted in terms of the statistical quantities that describe them. Absolute total mean power output measurements (with no post-detection filtering) are compared with theoretical curves. A large number of output spectra for various operational conditions and for three different IF filter characteristics are shown together with theoretical data where these are available. Relative peak spectral intensities for related cases, derived from the recorded spectra, are normalized and plotted with theoretical curves where possible. Chapter VI summarizes the main features of the experimental investigation. The gratifying agreement between theory and experiment, proclaims, in general, the adequacy of the mathematical models of the FM receiver and random noise, as well as the intermediate operations and calculations. Specifically, the noise-alone arbitrary-limiting results of Chapters II and III of the companion report are substantiated, as well as the limiter output results. The simpler cases as well are quite uniformly verified. The few discrepancies that turned up are classified in accordance with their probable explanations. Experimental results unchallenged by theoretical predictions are given for the cases of intermediate signal-to-noise ratio and arbitrary limiting, a narrow-banded limiter, and an off-tuned discriminator. (Contractor's abstract)

HAR.03:016 - HAR.03:019

HAR.03:016

Harvard U. Cruft Lab., Cambridge, Mass.

THEORY OF THE CORNER DRIVEN SQUARE LOOP ANTENNA, by R. King. Feb. 1, 1957 [14]p. incl. diagrs. refs. (Technical rept. no. 222) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 126000 Unclassified

Also published in Electromagnetic Wave Theory Symposium, p. 393-407, 1957.

The general problem of determining the distribution of current and the driving point impedances of a square loop or frame antenna is formulated when arbitrary driving voltages are applied at each corner or when up to three of these voltages are replaced by impedances. The loop is unrestricted in size and account is taken of the finite cross-section of the conductors. Four simultaneous integral equations are obtained and then replaced by four independent integral equations using the method of symmetrical components. These equations are solved individually by iteration and first-order formulas are obtained for the distributions of current and the driving-point admittances. By superposition the general solution for the arbitrarily driven and loaded loop is obtained. Interesting special cases include a corner-reflector antenna and the square rhombic (terminated) antenna. An application of the principle of complementarity permits the generalization of the solution to the square slot antenna in a conducting plane when driven from a double-slot transmission line at one corner. (Contractor's abstract)

HAR.03:017

Harvard U. Cruft Lab., Cambridge, Mass.

WAVE PROPAGATION IN A FERRITE STRUCTURE. I, by T. T. Wu. Mar. 20, 1957, 30p. incl. diagrs. (Technical rept. no. 251) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 133491 Unclassified

An analytical procedure of studying wave propagation in ferrites is presented with special reference to the analysis of an isolator in a rectangular waveguide. The isolator considered consists of a waveguide section partly filled with a ferrite material and with conducting strips spaced along one face of the ferrite slab. Algebraic equations are derived for the propagation constant. (Contractor's abstract)

HAR.03:018

Harvard U. Cruft Lab., Cambridge, Mass.

THE SECONDARY EMISSION PULSE CIRCUIT: ITS ANALYSIS AND APPLICATION, by J. A. Narud. Apr. 5, 1957 [42]p. incl. diagrs. table, refs. (Technical rept. no. 245) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 131984 Unclassified

Also published in I.R.E. Trans. of Professional Group on Electronic Computers, v. EC-9: 439-451, June 1960.

In the fields of high-speed computers, guided missile tracking systems and nuclear physics there has lately been an increasing demand for nonlinear active circuits capable of generating pulses in the millimicrosecond range at high repetition rates. In such circuits thermionic secondary emission tubes show great promise of replacing the ordinary vacuum tube. The reasons for this are twofold: First, these tubes have a much higher ratio between saturation current and electrode capacitance than ordinary vacuum tubes, resulting in a smaller rise time for the same voltage level. Second, with these tubes it is possible to design a positive feedback configuration that has a small loop delay so that the interval between the times it is possible to turn the circuit on and off can be minimized. This paper describes a regenerative pulse circuit using a single secondary emission tube that is able to generate pulses having a rise time of 6m s and a width continuously variable from 25m s to 12 s. First, a theoretical discussion of the circuit is given in which expressions for pulse width and resolving time are derived. Then various practical realizations of the circuit are presented. Among others these include a millimicrosecond pulse generator and a fast pulse-height discriminator. (Contractor's abstract)

HAR.03:019

Harvard U. Cruft Lab., Cambridge, Mass.

CYLINDRICAL ANTENNA IMMERSED IN A DISSIPATIVE MEDIUM (INPUT IMPEDANCE), by M. S. Macrakis. May 1, 1957, 10p. incl. illus. (Technical rept. no. 256) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 135165 Unclassified

Hallen's linearized integral equation (Theory of Linear Antennas by R. W. P. King, 1956) has the following form for a cylindrical antenna immersed in a dissipative medium in which the conductivity is very small:

$$\int_{-h}^h I(z') K(z | z') dz' = -\frac{14\pi}{\epsilon_0} [C \cos \beta z + \frac{1}{2} V_0 \sin \beta |z|]$$

with $K(z | z') = e^{-\frac{j\beta R}{R}}$, $R = [(z-z')^2 + a^2]^{1/2}$, $\beta = \beta' - j\beta''$.

Investigation is made of the case of $\beta'' \ll 1$, and

HAR.03:020 - HAR.03:022

$e^{-j\beta R} \pm (1 - \beta^2 R)e^{-j\beta R}$, or a Taylor's expansion in β^2 for the impedance can be introduced. The iteration and variational methods of solving the integral equation are studied. The simplest is the variational method with Taylor's expansion in β^2 for the impedance. The short antenna in a dissipative medium is discussed as a special case. (ASTIA abstract)

HAR.03:020

Harvard U. Cruft Lab., Cambridge, Mass.

AN EXPERIMENTAL SYSTEM FOR STUDYING THE ZEROS OF NOISE, by G. M. White. May 15, 1957 [53]p. incl. illus. diagrs. tables, refs. (Technical rept. no. 261) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 135934

Unclassified

For many years, researchers in the field of statistical communications have been interested in the zeros problem, i.e., the statistical distributions of the times a random voltage waveform passes through zero value. One of the most common waveforms investigated experimentally and theoretically is Gaussian noise. In this report an experimental system for generating and measuring the zeros of Gaussian noise is described. Various zero-crossing distributions found in the literature are briefly derived and calculations performed for the spectra that were experimentally synthesized. When the calculated distributions were checked with the experimental distributions from the system described, close agreement was reached. (Contractor's abstract)

HAR.03:021

Harvard U. Cruft Lab., Cambridge, Mass.

FERROMAGNETIC RESONANCE IN NICKEL FERRITE AT VERY LOW TEMPERATURES, by C. J. Hubbard. June 5, 1957 [69]p. incl. illus. diagrs. tables, refs. (Technical rept. no. 266) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 149934

Unclassified

Magnetic resonance experiments have been carried out at low-power levels on nickel ferrite single crystals at temperatures down to 1.57°K. The frequency of these measurements was 24,000 Mc/s (K-band). Line widths, first and second order anisotropy constants, and g-values were obtained. At low temperatures the line width became a strong function of the orientation of the applied d-c field, exceedingly narrow and exceedingly broad lines having been observed with the same sample. Subsidiary resonances of the Walker type were found at the lowest temperatures. Resonance measurements at

very high r-f power levels were also carried out on nickel ferrite at temperatures down to 4.2°K, using 9000 Mc/s (X-band). Changes in the magnetization were observed, and the relaxation time τ_1 determined following Bloembergen and Wang. The predictions of the Suhl nonlinear theory are verified with respect to the critical field for the decline of the main resonance and the position of the subsidiary absorption. Oscillograms showing the growth of the parasitic spin waves are presented. The relaxation time is also evaluated for the very long spin waves excited at the subsidiary absorption. It is shown that the relaxation time is relatively independent of temperature and of the wave number of the spin waves concerned. An explanation of this behavior is suggested. (Contractor's abstract)

HAR.03:022

Harvard U. Cruft Lab., Cambridge, Mass.

EXPERIMENTAL DETERMINATION OF THE ZERO CROSSING DISTRIBUTION $W(N,T)$, by G. M. White. June 15, 1957 [35]p. incl. illus. diagrs. tables. (Technical rept. no. 265) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 146013

Unclassified

In Cruft Laboratory technical report no. 261 (item no. HAR.03:020), an experimental system was described for use in accurately locating in time the zeros of noise for 2 broad band power spectra. Later, this system was used to obtain experimental curves of:

- $W(N,T)$, the probability of having N zero-crossings in a time interval T ;
- \bar{N} , the average number of zero-crossings in a time interval T ; and
- $\overline{N^2}$, the average of the square of the number of zero-crossings in a time interval of length T , where Gaussian noise having a spectral shape of

$$\frac{1}{1 + \left(\frac{1}{Q^2} - 2\right) \left(\frac{f}{f_0}\right)^2 + \left(\frac{f}{f_0}\right)^4}$$

was employed. This study presents a description of the additional equipment built and graphs of the resulting curves. Broad band noise ($Q = 1/2$ and $1/\sqrt{2}$), narrow band noise ($Q = 10$), and intermediate cases ($Q = 6$ and 10) were considered. The curves obtained that could be checked [\bar{N} and $\overline{N^2}$] were found to agree closely with the calculated curves; the other $W(N,T)$ were found to agree with theoretical predictions. It is hoped that theoreticians, by examining the curves given will gain some insight into the solution of the zero-crossing problem for noise alone. (Contractor's abstract)

HAR.03:023 - HAR.03:026

HAR.03:023

Harvard U. Cruft Lab., Cambridge, Mass.

THE SCATTERING OF CONDUCTION ELECTRONS BY IMPURITIES IN METALS, by L. M. Roth. June 25, 1957, 112p. incl. diagrs. tables, refs. (Technical rept. no. 267) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 147173

Unclassified

The scattering of electrons by impurities in metals is studied in this report by a Green's function method which takes into account the band structure. The Green's function for an electron in a periodic potential is used to demonstrate the form which the scattered waves take far from the scattering center. The method is specifically applied to the case of a spherically symmetric impurity confined to one atomic cell in a monovalent metal, where an approximate generalization of the method of partial waves is derived, which includes the effect of the crystalline field as well as the type of impurity. This result is extended by a perturbation method to include the effect of a potential tail outside of the impurity cell. It is proved that Friedel's sum rule, which relates the phase shifts to the excess charge introduced about the impurity, holds for the case of a spherical energy surface. These results are applied to the case of monovalent impurities in monovalent metals, and a generalization of Mott's square well approximation is obtained, which includes the effect of the crystalline field in the band edge approximation. The residual resistivity of noble metal alloys is computed using the calculation of Kambe for the wave functions. When the scattering due to the lattice strain is also included, the agreement with experimental results is found to be considerably better than in the Mott approximation. The effect of including the polarization of the conduction electrons is discussed, and it is found that this correction, while important, is not so drastic as in the Mott approximation. The results are also applied to the thermoelectric power in one case. Preliminary results are given for the residual resistivity of alkali metal alloys. (Contractor's abstract)

HAR.03:024

Harvard U. Cruft Lab., Cambridge, Mass.

THE PRESSURE DEPENDENCE OF THE KNIGHT SHIFT IN THE ALKALI METALS AND COPPER, by G. B. Benedek and T. Kushida. July 1, 1957 [35]p. incl. diagrs. tables, refs. (Technical rept. no. 268) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 145484

Unclassified

Also published in Jour. Phys. Chem. Solids, v. 5: 241-255, 1958.

Measurements of the pressure dependence of the Knight shift in Li, Na, Rb, Cs, Cu, and Al have been made at room temperature in the pressure range 1 to 10,000 kg/cm². The volume dependence of

$\langle |\psi_F(0)|^2 \rangle = P_F$ has been deduced from these data

using Pines' collective electron picture for the paramagnetic susceptibility of the conduction electrons. The results of recent calculations of the volume dependence of P_F are presented and compared with the experimentally deduced results. The Knight shift is shown experimentally to be an explicit function of the temperature at constant volume. A theory, which takes into account semi-quantitatively the effect of the lattice vibrations on P_F , is proposed. Comparison is made between this theory and the experimental observations. (Contractor's abstract)

HAR.03:025

Harvard U. Cruft Lab., Cambridge, Mass.

TWO NEW PULSE-DIVIDING CIRCUITS, by R. A. Winter and J. A. Narud. July 1, 1957 [25]p. incl. illus. diagrs. (Technical rept. no. 255) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 141638

Unclassified

Many of today's electronic devices, such as computers, radar units and television systems, require synchronized waveforms the frequencies of which are a submultiple of some master frequency. A great variety of different circuits, commonly called "frequency dividers," have been designed for that purpose and described in the literature. It is the purpose of this paper to introduce and to describe two simple and very reliable divider schemes for a fixed input frequency using a delay line, on the one hand, and a sawtooth generator, on the other, to produce the timing waveform. (Contractor's abstract)

HAR.03:026

Harvard U. Cruft Lab., Cambridge, Mass.

AN EXPERIMENTAL SYSTEM FOR MEASURING CERTAIN TRANSIENT NUCLEAR MAGNETIC RESONANCE PHENOMENA, by P. P. Sorokin and N. Bloembergen. July 15, 1957 [16]p. incl. illus. diagrs. (Technical rept. no. 269) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 147172

Unclassified

A description is given of experimental equipment and methods used to study some recently observed effects in nuclear magnetic resonance centering around the transverse relaxation time at high r-f fields in solids

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with two kinds of nuclear spins. Studies are reported of these effects with regard to the Cs^{133} nuclei in the cesium halides; the effects can be observed with other insulating crystals providing certain conditions are fulfilled. The equipment described was primarily designed to measure the transverse relaxation time T_{2e} in the presence of high r-f fields, as well as the spectrum of the steady-state transverse nuclei magnetization which is produced in a new-type of double resonance experiment. Each kind of measurement is briefly discussed.

HAR.03:027

Harvard U. Cruft Lab., Cambridge, Mass.

THREE NOTES ON SOME ELECTRON FLOW PROBLEMS, by G. Kent. Aug. 30, 1957 [22]p. incl. illus. diags. refs. (Technical note no. 273) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186616) AD 146084 Unclassified

Part I. Stability of Double Stream Flow. The question of whether or not a two-velocity electron beam which can support exponentially growing space-charge waves is stable in time is examined. On the basis of a simple mathematical model, it is shown that the entrance condition of zero excitation implies zero wave amplitudes. Part II. A Collector for Improving the Efficiency of a Hollow Beam Klystron. A collector which returns to the power supply a large portion of the energy remaining in the beam of a hollow beam klystron is suggested. In the ideal case, 99 per cent of the energy is theoretically extracted from the spent beam, although not necessarily at useful voltage levels. Part III. Internal Emitters. A statistical analysis of plane and cylindrical emitters is presented. Although the analysis is restricted to equilibrium conditions, some of the experimentally known properties of internal emitters may be inferred. These properties lead to the conclusion that such emitters are seldom suitable for cathodes in practical vacuum tubes. (Contractor's abstract)

HAR.03:028

Harvard U. Cruft Lab., Cambridge, Mass.

THE RECTIFICATION OF NON-GAUSSIAN NOISE, by J. A. Mullen and D. Middleton. [1958] [25]p. incl. diags. tables, refs. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under [Nonr-186616]) Unclassified

Published in Quart. Appl. Math., v. 15: 395-419, Jan. 1958.

The types of noise functions considered are of the type

$V_N(t) = \sum_j v_j(t - t_j)$, where $\{t_j\}$ are the instants of a Poisson process of density ν , and $v_j(t) = h(t) \cos(\omega_0 t + \alpha_j)$, $\omega_0 > 1$, where either (i) $h(t) = e^{-t}$, $t > 0$, (ii) $h(t) = e^{-t^2}$, or (iii) $h(t) = 1$, $0 < t < 1$. The stochastic process of interest is $I(t) = g[V_N(t) + A_0 \cos \omega_0 t]$, where $g(V) = \beta \{\max(0, V)\}^\nu$, $\nu > 0$; the magnitude A_0 corresponds to the signal strength. A number of approximations are computed to the correlation function of $I(t)$, corresponding to low and high ν , and low and high signal strengths. Their expressions become more tractable when $\nu = 1$ or 2 , but even then are quite complicated. A number of the formulas are represented graphically, and a qualitative discussion of the results is given. (Math. Rev. abstract)

HAR.03:029

Harvard U. [Cruft Lab.] Cambridge, Mass.

PRESSURE DEPENDENCE OF THE PURE QUADRUPOLE RESONANCE FREQUENCY IN METALLIC GALLIUM (Abstract), by T. Kushida and G. B. Benedek. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under [Nonr-186616]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 167, May 1, 1958.

The pure quadrupole resonance of the Ga^{69} nucleus in metallic gallium has been studied under hydrostatic pressure in the range 1 to 8000 kg/cm^2 at 0°C , -29.8°C , -75°C . It was found that ν varies linearly with the pressure at all temperatures. $(d\nu/dP)_T$ is 16.1×10^{-3} kc/hg/cm^2 , 15.8×10^{-3} kc/hg/cm^2 , 15.4×10^{-3} kc/hg/cm^2 at 0° , -29.8° , and -75°C , respectively. No appreciable change was found in the line width as the pressure was increased. In view of the anisotropy in the thermal expansion, the probable anisotropy of the compressibility and the absence of knowledge as to the size of the asymmetry parameter, a detailed analysis of these results cannot now be given. However, a semiquantitative analysis of the results in terms of the volume dependence of the effective field gradient tensor components will be offered. This analysis will be applied to a discussion of the possible sources of the field gradient.

HAR.03:030 - HAR.03:033

HAR.03:030

Harvard U. [Cruft Lab.] Cambridge, Mass.

ZERO-FIELD SPLITTING IN NICKEL FLUOSILICATE (Abstract), by W. M. Walsh, Jr. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under [Nonr-186616]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 178, May 1, 1958.

Paramagnetic resonance measurements of the zero-field splitting D in single crystals of $\text{NiSiF}_6 \cdot 6\text{H}_2\text{O}$ have been made as a function of hydrostatic pressure P, and uniaxial stress U, the latter being applied along the crystalline symmetry axis. The results are

$$1/D(\partial D/\partial P)_T = 1.60 \times 10^{-4} \text{ (kg/cm}^2\text{)}^{-1} \text{ and}$$

$$1/D(\partial D/\partial U)_T = 3.18 \times 10^{-4} \text{ (kg/cm}^2\text{)}^{-1} \text{ respectively.}$$

The anisotropic changes in sample dimensions due to these forces as well as the thermal expansion have been measured. Combining these data with the temperature dependence of D permits a phenomenological calculation of the zero-field splitting dependence on unit cell shape and volume and of the explicit temperature dependence due to lattice vibrations.

HAR.03:031

Harvard U. [Cruft Lab.] Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE IN THE CESIUM HALIDES, by N. Bloembergen and P. P. Sorokin. [1958] [11]p. incl. illus. diagrs. table. refs. [Technical rept. no. 274] (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under [Nonr-186616] AD 218457 Unclassified

Also published in Phys. Rev., v. 110: 865-875, May 15, 1958.

The chemical shifts, the spin-lattice relaxation times, the isotropic exchange coupling A, and the pseudo-dipolar exchange coupling B between cation and anion nuclear spins have been determined in a single crystal of CsBr. The results are: $\sigma_{\text{Cs}} = (-1.9 \pm 0.4) \times 10^{-4}$, $\sigma_{\text{Br}} = (-2.5 \pm 0.3) \times 10^{-4}$, $(T_1)_{\text{Cs}} = 1050 \pm 40 \text{ sec}$, $(T_1)_{\text{Br}} = 0.105 \pm 0.020 \text{ sec}$, $h^{-1}|\tilde{A}| = 55 \text{ sec}^{-1}$, $h^{-1}\tilde{B} = 15 \text{ or } -89 \text{ sec}^{-1}$. Similar, but less complete, data have

been obtained for a single crystal of CsI and a CsCl powder. The results are discussed in terms of existing theories for the chemical shift and exchange interactions in solids. An average of 25% covalent bonding per ion is deduced. The large ratio of T_1 for Cs and Br, respectively, sets an upper limit to the quadrupole moment of Cs^{133} : $|Q| < 0.004 \times 10^{-24} \text{ cm}^2$. This large difference in the spin-lattice interactions between the nuclear species is responsible for some new effects.

The decay time T_{2e} for the transverse Cs^{133} magnetization is proportional to $H_1^2(\nu_{\text{Cs}})$ for a wide power range of the ratio-frequency field at the Cs^{133} Larmor frequency. It is furthermore possible to build up a transverse Cs^{133} magnetization by applying, simultaneously with $H_1(\nu_{\text{Cs}})$, a radio-frequency field $H_1^{\text{Br}}(\nu)$

at a frequency $\nu = \nu_{\text{Br}} \pm \gamma_{\text{Cs}} H_1^{\text{Cs}} / 2\pi$. Here ν_{Br} is the bromine precession frequency. A theory of these effects shows that the relatively weak interaction constants A and B between cesium and halogen spins can be determined with much higher accuracy than would have been possible from the usual second moment determinations.

HAR.03:032

Harvard U. Cruft Lab., Cambridge, Mass.

GERMANIUM SURFACE STUDIES, by A. B. Fowler. July 1, 1958 [72]p. incl. diagrs. tables, refs. (Technical rept. no. 275) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research) under Nonr-186616) AD 204469 Unclassified

This report on germanium surface studies is divided into three parts: I. Introduction; II. P-N Junction Measurements; and III. Interpretation of Results on P-N Junctions. Part I discusses work function, surface states, surface potential and statistics, cleaning of surfaces, adsorption of gases, and physical measurements of cleaned surfaces. Part II presents the introduction, germanium samples, the reference, the experimental tube, the vacuum system, measurement of contact potential, measurements of the photovoltage, temperature measurements, cleaning of the samples in vacuum, measurements on Argon-bombarded surfaces, results of simultaneous bombarding and annealing, and the effect of gaseous contamination. Part III discusses the cleanliness of surfaces, estimates of the number of surface states, and the effect of oxygen adsorption.

HAR.03:033

Harvard U. Cruft Lab., Cambridge, Mass.

DEDUCTION OF THE VOLUME DEPENDENCE OF THE

HAR.03:034; HAR.09:001

COHESIVE ENERGY OF SOLIDS FROM SHOCK WAVE COMPRESSION MEASUREMENTS, by G. B. Benedek. Nov. 20, 1958 [26]p. incl. diagrs. tables, refs. (Technical rept. no. 286) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-186616) AD 208632

Unclassified

Also published in Phys. Rev., v. 114: 467-475, Apr. 15, 1959.

By applying the Mie-Gruneisen equation of state to measurements of the compression of solids by strong shock waves, it is possible to determine the volume dependence of the cohesive energy. The method for carrying out this deduction is presented along with a detailed exposition of the underlying assumptions. The method is applied to six metals, Be, Al, Co, Ni, Cu and Ag, for which the experimental data are most extensive. The volume dependence of the cohesive energy for these six metals is presented in both analytical and graphical form. (Contractor's abstract)

HAR.03:034

Harvard U. Cruft Lab., Cambridge, Mass.

ENERGY BANDS IN SOLIDS - THE QUANTUM DEFECT METHOD, by H. Brooks and F. S. Ham. Dec. 15, 1958 [18]p. incl. tables, refs. (Technical rept. no. 295) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-186616) AD 213444

Unclassified

Also published in Phys. Rev., v. 112: 344-361, Oct. 15, 1958.

This paper describes a procedure for the calculation of electron energy bands in certain solids from spectroscopic data for the corresponding free atom. This method is an improved version of one used by Kuhn and Van Vleck to calculate the energy bands of sodium, potassium, and rubidium. It avoids explicit construction of a one-electron potential to represent the interaction between the valence and core electrons. It is assumed that the interaction between a valence electron and an ion in the crystal is approximately the same as in the isolated atom. If the interaction is accurately represented by a Coulomb potential outside the ion core, one may express solutions of the radial differential equation in this region as linear combinations of standard Coulomb functions. The combination corresponding to the solution which is well-behaved at the nucleus involves a coupling constant which depends upon the ion potential through a parameter that is a slowly varying function of the energy. At an eigenvalue this parameter can be evaluated from the quantum defect. Hence if the eigenvalue spectrum is known, we may obtain this parameter by extrapolation for arbitrary nearby energies, and the regular solution of the radial equation is consequently determined explicitly, outside the core. This is

sufficient information for the calculation of energy bands with available techniques. An approximate formula is established for the ratio of the amplitude of the wave function near the nucleus to its value at a point outside the core. For an s function this relation involves only the nuclear charge, standard Coulomb functions, and the aforementioned parameter derived from spectroscopic data. It therefore provides a convenient means of calculating P_F and P_A , the squared amplitudes at the nucleus appropriate to the Knight shift and the atomic hyperfine splitting, respectively. In the latter case the result is identical with a formula given by Fermi and Segre, which gives reasonable agreement with experiment. Arguments are presented in support of the thesis that the quantum defect method takes very general account of exchange and correlation interactions between the valence electron and core electrons. Relativistic effects, including spin-orbit coupling are also included naturally. Modifications are discussed of the method to take into account deviations of the ion or crystal potential outside the core from Coulomb form. Tables of the essential data, including improved polarization corrections, are given for the alkali metals. (Contractor's abstract)

HAR.09:001

Harvard U. Cruft Lab., Cambridge, Mass.

A STUDY OF MAGNETRON DIODE OSCILLATIONS, I, by J. M. Osepchuk. Dec. 30, 1957, 45p. incl. diagrs. refs. (Technical rept. no. 271) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186632) AD 159663

Unclassified

This work is concerned with the velocity-resonance type of oscillations which have been observed in magnetron diodes. In Chapter I the anomalous effects which are believed to be associated with these oscillations are reviewed and are shown to be in conflict with the classical steady-state theories of the magnetron diode even when emission velocities of electrons are taken into account. An explanation of these effects is shown to require either a state of statistical disorder in the space charge or a state of organized oscillations. In Chapter II the small-signal theory of a perturbed Brillouin state is treated with a review of previous work on this subject. Under the usual assumptions in the case of a small cathode, it is found that the space charge is stable with real frequencies of oscillation. This result is valid only if the space-charge cloud extends to a radius much greater than the cathode radius. In the general case with special conditions at the cathode, instability may be found. The central importance of the Hahn boundary condition in the theory of "M" type space-charge waves is shown. The derivation of this condition is reexamined with a clear statement of the conditions for its validity. An investigation is made of the effect of a finite boundary layer on the nature of the

HAR.09:002 - HAR.09:005

space-charge waves. Under special assumptions an instability if found, however, does not correspond to velocity-resonance oscillations. The results of this theoretical study are used (in Part II) (TR-272) to interpret the results of experiments which were conducted with a series of magnetron diodes. (Contractor's abstract)

HAR.09:002

Harvard U. Cruft Lab., Cambridge, Mass.

A STUDY OF MAGNETRON DIODE OSCILLATIONS, II, by J. M. Osepchuk. Dec. 30, 1957, 39p. incl. illus. diagrs. tables, refs. (Technical rept. no. 272) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186632) AD 159884

Unclassified

This report presents the results of an experimental study of oscillations in several magnetron diodes of varying dimensional parameters. Coupling to the oscillations was effected by the use of coupling slots in the anodes of the magnetrons. Frequency and power measurements were made over the ranges of voltage and magnetic field common to C-W magnetrons. The power measurements were related to interaction space r - f fields (assuming a slightly disturbed bounded cloud of space charge) with the results of a calculation of slot coupling (Appendix A). The frequency measurements are compared with the results of several theories which were studied in a previous report (TR-271). Although the measured frequencies are in best agreement with a formula of Guénard and Huber it is concluded that a satisfactory understanding of the mechanism of the oscillations is still lacking. The frequency measurements as a function of voltage and magnetic field, do confirm, however, the oscillations as a type of "velocity-resonance" oscillations. The power measurements lead one to conclude that a considerable proportion of the space charge is present beyond the bounding radius of the space-charge cloud in the classical steady-state theories. The detected signals were observed to be "noisy" at high cathode temperatures and "clean" at low cathode temperatures. It is probable that "clean" oscillations occur with a temperature-limited state in the magnetron. (Contractor's abstract)

HAR.09:003

Harvard U. Cruft Lab., Cambridge, Mass.

THE DRIVING POINT AND INPUT IMPEDANCE OF LINEAR ANTENNAS, by T. T. Wu and R. W. P. King. Mar. 20, 1958 [9]p. incl. diagrs. (Technical rept. no. 279) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-186632) AD 159662

Unclassified

An infinity in the input impedance of linear antennas owing to the use of an idealized delta-function generator is investigated. It is shown that the infinity may be interpreted in terms of an infinite capacitance between the two halves of the antenna. The conclusion is reached that conventionally used iterative procedures are not invalidated by difficulties with respect to the driving point. (Contractor's abstract)

HAR.09:004

Harvard U. Cruft Lab., Cambridge, Mass.

CURRENT DISTRIBUTIONS AND IMPEDANCES OF CORNER-DRIVEN SQUARE LOOP ANTENNAS, by S. Prasad. Apr. 10, 1958 [47]p. incl. illus. diagrs. tables, refs. (Technical rept. no. 259) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-186632) AD 158738

Unclassified

Square loop antennas driven in the zeroth-phase sequence (voltages in phase at all four corners) and the second-phase sequence (voltages alternately in and out of phase at the corners) have been studied. The theoretical input admittances and impedances have been calculated for each phase sequence and for a simple superposition of the two phase sequences. Current distributions and input admittances have been obtained experimentally for the same superposition of the two phase sequences. (Contractor's abstract)

HAR.09:005

Harvard U. Cruft Lab., Cambridge, Mass.

FIELD PATTERNS AS A FUNCTION OF ELEMENT PHASING AND ELEVATION ANGLE, by R. B. Mack. Apr. 10, 1958 [18]p. incl. diagrs. (Technical rept. no. 280) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186632) AD 182886

Unclassified

The directional characteristics of a complete array are only approximately given by patterns in the 2 principal planes. Minor lobes occur outside these principal planes, which are approximately as large as those occurring in the principal planes. Thus, in designing arrays for low minor lobes the patterns outside the principal planes should be considered. The factor which limits the amount the principal maximum can be moved by varying t_p (the phase difference between elements in fractions of a period), while still obtaining a useful pattern, is the shape of the pattern of the basic unit. No attempt has been made to determine the optimum realizable shape for the pattern of the basic unit, but this would be a useful piece of information. Some very useful information concerning t_{pm} can be

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HAR.05:002, 003

obtained by choosing fixed γ (the azimuthal angle measured from the x axis) and θ (the elevation angle measured from the z axis) and determining the pattern as a function of t_p . This is frequently easier to do than computing the pattern as a function of angle. A basic unit consisting of a unidirectional end-fire coupler permits a wide variation of t_p with small effects upon the principal maximum but "back lobe" becomes important as the limiting factor. The basic unit pattern from a dipole placed $\pi/4$ in front of a conducting screen has no "back lobe" but the range of variation of t_p is limited by the resulting change in the height of the principal maximum. Owing to the significance of the pattern of the basic unit in determining the pattern of a complete array, the properties of a non-uniform array may be expected to resemble qualitatively the uniform array discussed here.

HAR.09:006

Harvard U. Cruft Lab., Cambridge, Mass.

HIGH-FREQUENCY DIFFRACTION BY AN INFINITE SLIT, by T. T. Wu. Apr. 16, 1958, 16p. incl. diagr. (Technical rept. no. 281) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-186632) AD 158739 Unclassified

A systematic procedure is given for the determination of the high-frequency asymptotic series for the total scattering cross section of an infinite slit in the case of normal incidence and Neumann boundary condition. The series is expressed formally as an infinite determinant; then by evaluating the determinant, the first ten terms are obtained explicitly. (Contractor's abstract)

HAR.04:015

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

LOCATION OF ZEROS OF INFRAPOLYNOMIALS, by T. S. Motzkin and J. L. Walsh. Technical rept. Dec. 1956, 29p. (In cooperation with California U., Los Angeles) (AFOSR-TN-57-265) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under AF 18(600)998; continued by AF 18(600)1461) AD 126564 Unclassified

Also published in *Compositio Math.*, v. 14: 50-70, 1959.

If E is an arbitrary point set of the s -plane, the polynomial $q(s) = s^n + \dots$ is an underpolynomial of

$p(s) = s^n + \dots$ provided there is $|q(s)| < |p(s)|$ on E where $p(s) \neq 0$, $q(s) = \mu(s)$ on E where $p(s) = 0$. If $p(s)$ has no underpolynomial on E it is called an infrapoly-

nomial on E . The geometric location of zeros (and of the centers of gravity of zeros) of infra-polynomials on both bounded and unbounded sets is investigated. The methods of analysis used involve the detailed study of the behavior of unbounded sets in the neighborhood of infinity, with special reference to the level loci of the modulus or a rational function.

HAR.05:002

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

LIPSCHITZ CONDITIONS FOR HARMONIC AND DISCRETE HARMONIC FUNCTIONS, by J. L. Walsh and D. Young. July 1957, 21p. (In cooperation with Maryland U., College Park) (AFOSR-TN-57-404) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1461 and Office of Ordnance Research under DA 36-034-ord-1486) AD 132482 Unclassified

Also published in *Jour. Math. and Phys.*, v. 36: 138-150, July 1957.

Proof is given that if a function $u(x,y)$ is harmonic in a square or rectangle, and if boundary values of $u(x,y)$ are continuously assumed and satisfy on the boundary a Lipschitz condition of order α ($0 < \alpha < 1$): $|u(x_1, y_1) - u(x_2, y_2)| \leq L \delta^\alpha$, $\delta^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$, $\delta \geq 0$, so also does $u(x,y)$ in the closed region, with a suitable modification of the constant L . The expression is written as $u(x,y) \in \text{Lip } \alpha$. Proof is also given for the analogous result for discrete harmonic functions with uniformity of the Lipschitz condition for all mesh size. These results are applied to degree of convergence in a closed rectangle of the solution of the Dirichlet problem. Poisson's integral for the half plane is employed to obtain the results, and these in turn are used to solve the Dirichlet problem for a semi-infinite strip. A new vertical accordion process of folding a semi-infinite strip is introduced to cover infinitely often a square and thus to solve the Dirichlet problem for the square. These procedures with suitable modifications apply to both harmonic and discrete harmonic functions.

HAR.05:003

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

POLYNOMIALS OF BEST APPROXIMATION ON A REAL FINITE POINT SET. I, by T. S. Motzkin and J. L. Walsh. Technical rept. July 1957, 23p. (In cooperation with California U., Los Angeles) (AFOSR-TN-57-406) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under [AF 18(600)1461] AD 132484 Unclassified

Abstract published in *Proc. Nat'l. Acad. Sciences*, v. 43: 845-846, Sept. 1957.

HAR.05:004 - HAR.05:003

Also published in Trans. Amer. Math. Soc., v. 91: 231-245, May 1959.

A systematic study is presented of the common properties relating to oscillation of the difference $f(x) - p_n(x)$ of polynomials $p_n(x)$ of given degree n ($n \geq 0$) of best approximation to a given real function $f(x)$ on a given real finite point set E . Juxtapolynomials to a given real function $f(x)$ on a given real finite point E are defined as the closest polynomials to that function on that point. The totality of extremal polynomials for the classical deviations and unspecified positive weights is identical with the totality of juxtapolynomials. The striking relation between juxtapolynomials and weak oscillation of $f(x) - p_n(x)$ on E is discussed. A study is made of the properties of boundedness, closure, and connectedness of the set of juxtapolynomials, and of the characterization of juxtapolynomials relative to the special classical norms of $p > 1$, of Chebyshev, and of $0 < p < 1$.

HAR.05:004

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

THE THEORY OF SQUARE INTEGRABLE DIFFERENTIALS ON OPEN RIEMANN SURFACES, by L. V. Ahlfors. Jan. 1958, 52p. (AFOSR-TN-57-790) (AF 18(600)1461) AD 148021 Unclassified

Various orthogonal decompositions are shown to play a central role in the theory of differentials. In these cases the restrictions are not imposed on the Riemann surface. Generality is achieved by focusing the attention on certain subclasses of differentials. The following are discussed: (1) square integrable differentials, (2) Weyl's lemma, (3) DeRham's decomposition, (4) orthogonal complements, (5) periods, (6) finite surfaces, (7) semi-exact differentials, (8) Schottky differentials, (9) harmonic measures, (10) canonical homology bases, (11) isolated singularities, (12) closed singular differentials, (13) harmonic singular differentials, (14) canonical differentials, (15) period differentials, (16) modular differentials, and (17) Abel's theorem.

HAR.05:005

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

THE COMPLEX ANALYTIC STRUCTURE OF THE SPACE OF CLOSED RIEMANN SURFACES, by L. V. Ahlfors. [1957] [22]p. (AF 18(600)1461) Unclassified

Published in Analytic Functions; a Conference, Inst. for Advanced Study, Princeton, N. J. (Sept. 2-14, 1957), Princeton, Princeton U. Press, 1960, p. 45-66.

Let M_g be the set each element of which consists of a compact Riemann surface of genus g , together with a

fixed homotopy basis for the surface. Teichmüller has defined a metric, taking as the distance between 2 elements of M_g the logarithm of the infimum of the maximal dilation of all quasi-conformal maps (in the proper homotopy class) between the two surfaces. The author has shown that M_g is homeomorphic to $(6g - 6)$ -dimensional Euclidean space. In the present paper he establishes the following theorem: The space M_g of canonical Riemann surfaces of genus $g > 1$ permits 1 and only 1 complex analytic structure over the Teichmüller topology with respect to which all elements τ_{ij} of the Riemann matrix are analytic functions. The complex dimension of this structure is $3g-3$. Explicit calculations are made of the variations of the τ_{ij} under infinitesimal quasi-conformal maps. (Math. Rev. abstract)

HAR.05:006

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

APPROXIMATION BY BOUNDED ANALYTIC FUNCTIONS, by J. L. Walsh. Dec. 1957, 82p. incl. refs. (AFOSR-TN-58-79) (AF 18(600)1461) AD 148127 Unclassified

Also published in Trans. Amer. Math. Soc., v. 87: 467-484, Mar. 1958.

Methods are presented of approximating a given function of a complex variable by means of simpler functions. The principal results of recent theoretical studies are given in broad outline and also in some detail. One case deals with a function $f(z)$, analytic on a closed point set E , with a geometric degree of convergence. A second problem deals with weaker properties (as, for example, existence of derivatives and Lipschitz conditions) of a function $f(z)$ which is not analytic on E and which has a slower than geometric degree of convergence. The third problem concerns weaker properties of $f(z)$ not on E on a closed set E_1 which contains E and is contained in a region D . In this case $f(z)$ is analytic on E but not throughout E_1 and the degree of convergence on E is geometric but expressed with various refinements depending upon the properties of $f(z)$ on E_1 . The Taylor development of $f(z)$ is discussed. Approximation by polynomials and approximation by rational and analytic functions are described. Generalizations and extensions include geometric situations, continuity classes, other norms besides the Chebyshev norm as e.g., the p^{th} power integrals with or without a weight function, interpolation by functions of least norm, and extremal problems.

HAR.05:007 - HAR.05:011

HAR.05:007

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

APPROXIMATION BY BOUNDED ANALYTIC FUNCTIONS, by J. L. Walsh. Dec. 1957, 12p. (AFOSR-TN-58-80; Abridged version of AFOSR-TN-58-79, AD 148127) (AF 18(600)1461) AD 148128

Unclassified

The Taylor development of a function $f(z)$ which is analytic on a point set E (problem β , item no. HAR.05:006) is briefly discussed. An approximation is derived for the problem when the function $f(z)$ to be approximated on E is not analytic on E but has certain continuity properties on E (problem α).

HAR.05:008

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

APPROXIMATION ON A LINE SEGMENT BY BOUNDED ANALYTIC FUNCTIONS. PROBLEM β , by J. L. Walsh. [May 1958] 6p. (AFOSR-TN-58-393) (AF 18(600)1461) AD 154302

Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 270-272, Apr. 1959.

The problem β is the study of the degree of approximation on a closed bounded point set E to a function $f(z)$ analytic on E , by functions which are analytic and bounded in a region D containing E . The function $f(z)$ is supposed not necessarily analytic throughout D , but possesses certain continuity properties on the boundary of a suitable region of analyticity which contains E and whose closure lies in D . Recent progress has been made in the case in which E is bounded by analytic Jordan curves; the present paper discusses the case in which E is a line segment.

HAR.05:009

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON CANONICAL CONFORMAL MAPS OF MULTIPLY CONNECTED REGIONS, by J. L. Walsh and H. J. Landau. May 1958 [25]p. (In cooperation with Bell Telephone Labs., Inc., Murray Hill, N. J.) (AFOSR-TN-58-394) (AF 18(600)1461) AD 154303

Unclassified

Also published in Trans. Amer. Math. Soc., v. 93: 81-96, Oct. 1959.

An application of the following theorem is made: Let D be a region of the extended z -plane whose boundary consists of mutually disjoint Jordan curves $B_1, B_2, \dots, B_\mu; C_1, C_2, \dots, C_\nu, \mu, \nu \neq 0$. There exists a conformal map of D onto a region Δ of the extended z -plane, one

to one and continuous in the closures of the two regions, where Δ is defined by

$$1 < |T(z)| < e^{\frac{1}{\tau}}, T(z) = \frac{A(z-a_1)^{M_1} \dots (z-a_\mu)^{M_\mu}}{(z-b_1)^{N_1} \dots (z-b_\nu)^{N_\nu}},$$

with $M_1, N_1, \tau > 0, \sum M_1 = \sum N_1 = 1$. The purpose is to

show, using closely related methods, that the theorem extends to the case of domains in which the sets

$U_1 = \bigcup_{i=1}^{\mu} B_i$ and $U_j = \bigcup_{i=1}^{\nu} C_i$ are made up of Jordan curves that are not necessarily disjoint. The development is carried out by using several preliminary definitions and the result is applicable in the study of approximation by rational and by bounded analytical functions.

HAR.05:010

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

INTEGRATED CONTINUITY CONDITIONS AND DEGREE OF APPROXIMATION BY POLYNOMIALS OR BY BOUNDED ANALYTIC FUNCTIONS, by J. L. Walsh and H. G. Russell. May 1958, 29p. Incl. refs. (AFOSR-TN-58-395) (AF 18(600)1461) AD 154304

Unclassified

Also published in Trans. Amer. Math. Soc., v. 92: 355-370, Aug. 1959.

An analysis is given, with a minimum of detail, which shows that degree of approximation in the mean by polynomials of a complex variable and by bounded analytic functions is also conveniently investigated by use of integrated Lipschitz conditions. The investigations lead naturally to the use of classes of analytic functions satisfying integrated Zygmund and integral asymptotic conditions.

HAR.05:011

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

A GENERALIZATION OF FABER'S POLYNOMIALS, by J. L. Walsh. May 1958, 21p. (AFOSR-TN-58-417) (AF 18(600)1461) AD 158220

Unclassified

Also published in Math. Ann., v. 136: 23-33, 1958.

Faber's method is modified for application to the problem of the simultaneous expansion in several disjoint Jordan regions of a function analytic in those regions. This procedure involves (1) the use of a suitable sequence of interpolation polynomials convergent in the interior of a lemniscate leading to a series similar to that of Jacobi, and (2) the conformal mapping of the exterior of the lemniscate onto the exterior of given closed

HAR.05:012 - HAR.05:014

Jordan regions: the expansion of this mapping function yields the new polynomials. These functions are considered a generalization of Faber's polynomials because (1) they are defined by an interpolation series expansion of the first member of

$$\frac{\psi'(\tau)}{\psi(\tau) - z} = \frac{b_0(z)}{\tau - \alpha_1} + \frac{b_1(z)}{(\tau - \alpha_1)(\tau - \alpha_2)} + \dots$$

where $z = \psi(w)$ is a schlicht map onto the complement of E (E is the union of mutually disjoint continua, none of which is a single point, in the z -plane, and each of whose complements is an infinite region) so that

$\psi(\infty) = \infty$; (2) the expansion $f(z) = \sum_{k=0}^{\infty} a_k b_k(z)$ becomes the classical Faber expansion if $\nu = 1$ and becomes the Taylor expansion if E is a circular disk; (3) if $f(z)$ is analytic on E the expansion (2), like the Faber expansion, converges to $f(z)$ on E with the greatest geometric degree of convergence; (4) the $b_n(z)$ are unchanged if

E is replaced by E_σ (the point set $|U(z)| < \sigma$; and

(5) the relation $\limsup [\max |b_n(z)|, z \text{ on } E]^{1/n} =$

$\delta(E) = \mu$ is satisfied.

HAR.05:012

Harvard U. Dept. of Mathematics, Cambridge, Mass.

NOTE ON APPROXIMATION BY BOUNDED ANALYTIC FUNCTIONS (PROBLEM α), by J. L. Walsh. Aug. 1958, 12p. (AFOSR-TN-58-701) (AF 18(600)1461) AD 162235; PB 137873

Unclassified

Also published in Math. Zeitschr., v. 72: 47-52, 1959.

Problem α is a study of the relation of the degree of approximation of a function $f(z)$ on a point set E to the continuity properties on E of the function when the difference between the function and $f_n(z)$ is bounded by $n^{-p+\alpha}$ and $f_n(z)$ is bounded by R^n in a region D which contains E . A relationship is given between the function defined above and the existence of polynomials which approximate $f(z)$ such that the difference between $f(z)$ and $p_n(z)$ is bounded by $n^{-p+\alpha}$. This relationship presented is important due to the presently existing theory on problem α for polynomials and the possibilities of enlarging the region D in which $f_n(z)$ satisfy the needed approximation of $f(z)$.

HAR.05:013

Harvard U. Dept. of Mathematics, Cambridge, Mass.

APPROXIMATION BY BOUNDED ANALYTIC FUNCTIONS: GENERAL CONFIGURATIONS, by J. L.

Walsh. Aug. 1958, 10p. (AFOSR-TN-58-703) (AF 18(600)1461) AD 162237; PB 137872

Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 280-285, Apr. 1959.

A proof is presented of a theorem regarding the topological properties of point sets. Let $B =$

$\sum_{j=1}^{\mu} B_j$ and $C = \sum_{j=1}^{\nu} C_j$ be a set of mutually disjoint ana-

lytic Jordan curves. Let D be a bounded open set whose boundary is all of C plus a subset of B_j (not necessarily proper), and let each maximal subregion of D be bounded by a non-empty subset of B_j plus a non-empty subset of

C . Let C not separate D . Let E be a closed set disjoint from D whose boundary is B , but E need not be the closure of an open set. Let $D + E$ be connected. Let $u(z)$ be the harmonic function in D , continuous in the closure of D , equal to zero on B and unity on C . Let Γ_σ , $0 < \sigma < 1$, denote generically the locus $u(z) = \sigma$ in D , and let D_σ denote the set $0 < u(z) < \sigma$. Let the function

$f(z)$ be analytic in the interior points of E , continuous on E , and analytic in D_ρ , where Γ_ρ has no multiple points. Let $f(z)$ be of class $L(p, \alpha)$ on Γ_ρ . Then there exists functions $f_n(z)$ analytic in the interior points of $D + E$ and continuous on E , satisfying the following inequalities:

$$(1) |f(z) - f_n(z)| \leq \frac{A_1 e^{-n\rho}}{n^{p+\alpha}}, z \text{ on } E,$$

$$(2) |f_n(z)| \leq \frac{A_2 e^{n(1-\rho)}}{n^{p+\alpha}}, z \text{ in } D + E, (n = 1, 2, \dots).$$

HAR.05:014

Harvard U. Dept. of Mathematics, Cambridge, Mass.

EXPANSIONS IN SERIES OF HOMOGENEOUS POLYNOMIAL SOLUTIONS OF THE GENERAL TWO-DIMENSIONAL LINEAR PARTIAL DIFFERENTIAL EQUATION OF THE SECOND ORDER WITH CONSTANT COEFFICIENTS, by D. V. Widder. Sept. 1958, 8p. (AFOSR-TN-58-706) (AF 18(600)1461) AD 162240; PB 137863

Unclassified

Also published in Duke Math. Jour., v. 26: 599-603, Dec. 1959.

The region of convergence of series solutions of polynomials for the linear second order partial differential equation has been studied. If the equation is hyperbolic, the solutions are convergence in a rectangular region and possible on the extended diagonals of the rectangle as shown (see item no. HAR.05:015). If the equation is

HAR.05:015 - HAR.05:016

elliptic, the region of convergence is an ellipse given in terms of a limit term of the series coefficients, plus perhaps certain points outside the ellipse, such as diameters extended beyond the boundary. In the parabolic case the region of convergence is an infinite strip whose sides are characteristics plus perhaps portions of a single line extended beyond the strip through the origin.

HAR.05:015

Harvard U. Dept. of Mathematics, Cambridge, Mass.

EXPANSIONS IN SERIES OF HOMOGENEOUS POLYNOMIAL SOLUTIONS OF THE TWO-DIMENSIONAL WAVE EQUATION, by D. V. Widder. Sept. 1958, 14p. (AFOSR-TN-58-707) (AF 18(600)1461) AD 162241; PB 137864 Unclassified

Also published in Duke Math. Jour., v. 26: 591-598, Dec. 1959.

The convergence of the solutions of the two-dimensional wave equation given as an expansion in homogeneous polynomials has been investigated. Absolute convergence for the Taylor series expansion has been found in a rectangular region which is given in terms of the coefficients of the series and possible for the extended diagonals of the rectangle. A brief discussion is given of the relation of the above results to the Cauchy problem for the wave equation.

HAR.05:016

Harvard U. Dept. of Mathematics, Cambridge, Mass.

NOTE ON LEAST-SQUARE APPROXIMATION TO AN ANALYTIC FUNCTION BY POLYNOMIALS, AS MEASURED BY A SURFACE INTEGRAL, by J. L. Walsh. Aug. 1958, 13p. (AFOSR-TN-58-708) (AF 18(600)1461) AD 162242; PB 137826 Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 273-279, Apr. 1959.

A study is presented of the degree of approximation of analytic functions in the mean in a closed region D bounded by an analytic Jordan curve C. The results are of the same form as the results previously presented (see item no. HAR.05:010) for the necessary and sufficient conditions for the function to be approximated on the curve C by a polynomial expansion.

HAR.05:017

Harvard U. Dept. of Mathematics, Cambridge, Mass.

ON A SINGULAR BOUNDARY VALUE PROBLEM FOR AN EQUATION OF HYPERBOLIC TYPE, by E. T.

Copson. [1958] [8]p. (AFOSR-TN-58-999) (AF 18(600)-1461) AD 206142 Unclassified

Also published in Arch. Rational Mech. Anal., v. 1: 349-356, 1958.

The problem is to find a solution of

$$\frac{\partial^2 U}{\partial x^2} + \frac{2\alpha}{x} \frac{\partial U}{\partial x} = \frac{\partial^2 U}{\partial y^2} + \frac{2\beta}{y} \frac{\partial U}{\partial y}$$

where α, β are positive constants, such that (i) U and its first derivatives are continuous in $x \geq 0, y \geq 0$, (ii) the second derivatives of U are continuous in $x > 0, y > 0$, (iii) $U = f(x)$ when $y = 0, x \geq 0$; $U = g(y)$ when $x = 0, y \geq 0$; $f(0) = g(0)$.

HAR.05:018

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

[A THEOREM OF UNIQUENESS FOR THE EQUATION OF WAVES IN ONE DIMENSION] Un théorème d'unicité pour l'équation des ondes à une dimension, by E. T. Copson. [1958] [3]p. (AFOSR-TN-58-1000) [AF 18(600)1461] AD 206143 Unclassified

Also published in Compt. Rend. Seances Acad. Sci., v. 246: 2562-2564, May 1958.

If $u(x, t)$ satisfies the conditions: (A) u, u_t, u_x are continuous in the closed rectangle $\bar{A}: 0 \leq x \leq 1, 0 \leq t \leq T$; (B) $u_{tt}, u_{xx}, u_{tx}, u_{xt}$ exist and are bounded in the open rectangle, and $u_{xt} = u_{tx}$ there; (C) $u(x, 0) = u_t(x, 0) = 0, 0 \leq x \leq 1$; (D) $u_x u_t = 0$ for $x = 0, 1$ and $0 \leq t \leq T$; (E) $-u_{tt} + u_{xx} = 0$ in the open rectangle; then $u(x, t) = 0$ in \bar{A} . (Math. Rev. abstract)

HAR.05:019

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

SOLUTION OF THE DIRICHLET PROBLEM FOR THE ELLIPSE BY INTERPOLATING HARMONIC POLYNOMIALS, by J. L. Walsh. Oct. 1958, 7p. (AFOSR-TN-58-1001) (AF 18(600)1461) AD 206144; PB 137779 Unclassified

Also published in Jour. Math. and Mech., v. 9: 193-196, Mar. 1960.

A proof is presented of the theorem on the points of interpolation on the boundary of a given region D. In this case, D is the interior of an ellipse. Let the boundary B of a bounded region D in the (u, v)-plane be an ellipse and let the function $U(u, v)$ be defined and satisfy a Lipschitz condition of some positive order on

HAR.05:020-033; HAR.10:001

B with respect to arc length. Let the harmonic polynomial $p_n(u, v)$, of degree not greater than n , coincide with $U(u, v)$ in $2n + 1$ points equally spaced on B with respect to the conjugate of Green's function for the exterior of $D + B$ with pole at infinity. Then the sequence $p_n(u, v)$ converges to $U(u, v)$ uniformly on B, hence converges uniformly in $D + B$ to the corresponding solution of the Dirichlet problem.

HAR.05:020

Harvard U. Dept. of Mathematics, Cambridge, Mass.

ON THE RIEMANN-GREEN FUNCTION, by E. T. Copson. [1958] [25]p. incl. diagrs. (AFOSR-TN-58-1002) (AF 18(600)1461) AD 206145 Unclassified

Also published in Arch. Rational Mech. Anal., v. 1: 324-348, 1958.

This paper surveys the known methods of finding the Riemann-Green function and lists all of the major known cases. The use which is being made of this function in some recent developments of partial differential equations makes this account very useful, since the author has provided the reader with the evolutionary ideas as well as specific examples. (Math Rev. abstract)

HAR.05:021

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON THE ANALOGUE FOR MAXIMALLY CONVERGENT POLYNOMIALS OF JENTZSCH'S THEOREM, by J. L. Walsh. Dec. 1958, 22p. (AFOSR-TN-58-1086) (AF 18-(600)1461) AD 207583; PB 144344 Unclassified

Also published in Duke Math. Jour., v. 26: 605-616, Dec. 1959.

A study is presented of the analogue of Jentzsch's theorem, that every point of the circle of convergence of a Taylor development is a limit point of zeros of the partial sums. The zeros are investigated of maximally convergent sequences of polynomials, including some illuminating special expansions. (Contractor's abstract)

HAR.05:022

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

THE METHOD OF ORTHOGONAL DECOMPOSITION FOR DIFFERENTIALS ON OPEN RIEMANN SURFACES, by L. V. Ahlfors. [1958] [15]p. (AF 18(600)1461) Unclassified

Published in Ann. Acad. Scient. Fenn., Series A. I., No. 249/7, 1958, 15p.

Let Γ be the space of square integrable differentials on an open Riemann surface W . Various orthogonal decompositions are considered in the space Γ which are useful in function theory. Some idea of the questions dealt with can be seen from the following list of relevant subspaces of Γ : the subspace Γ_c of closed differentials; the subspace $\Gamma_h = \Gamma_c \cap \Gamma_c^*$, the subspace of harmonic differentials; the subspace Γ_e of exact differentials; Γ_{co} , the closure of the subspace of closed differentials with compact carriers; Γ_{eo} , the closure of the subspace of differentials of functions with compact carriers; and the subspace Γ_{se} of semi-exact differentials, i.e., of differentials which are closed and have zero periods around all dividing cycles. The space Γ_{hm} is defined by the orthogonal decomposition $\Gamma_h = \Gamma_{hse} + \Gamma_{hm}^*$. It is shown that $\Gamma_{hm} \subset \Gamma_{he} \cap \Gamma_{ho}$ with equality for finite Riemann surfaces. It is also shown that each differential in Γ_{hm} is the limit in norm of a suitable sequence of harmonic measures on an exhaustion of W . Considerable use is made of Schottky differentials on a finite Riemann surface. The remainder of the paper deals with the application of the method of orthogonal decomposition to the case of differentials with prescribed singularities and periods, and with a generalization of Abel's theorem. (Math. Rev. abstract)

HAR.10:001

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

THE PROBLEM OF MINIMAL MODELS IN THE THEORY OF ALGEBRAIC SURFACES, by O. Zariski. Oct. 1957 [39]p. incl. refs. (AFOSR-TN-57-691) (AF 18(600)1503) AD 136685 Unclassified

Also published in Amer. Jour. Math., v. 80: 146-184, Jan. 1958.

The two theorems listed below have been shown to hold in the abstract case ($p \neq 0$) for algebraic surfaces. By use of the properties of exceptional curves of the second kind, fundamental theorem A has been shown to be a consequence of fundamental theorem B. Fundamental theorem A: if a birational class C of non-singular surfaces contains no minimal model, then C contains a ruled surface. Fundamental theorem B: if a non-singular surface F carries an irreducible exceptional curve E of the second kind, then F is birationally equivalent to a ruled surface, and if, furthermore, the self-intersection number (E^2) of E is strictly positive, then F is a rational surface.

HAR. 10:002-004; HAR. 06:017

HAR.10:002

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

INTRODUCTION TO THE PROBLEM OF MINIMAL MODELS IN THE THEORY OF ALGEBRAIC SURFACES, by O. Zariski. July 25, 1957, 84p. incl. refs. (AFOSR-TN-57-517) (AF 18(600)1503) Unclassified

Also published as Publication of the Math. Soc. Japan, No. 4, Tokyo, Math. Soc. of Japan, 1958, 89p.

A modern approach to the classical problems of the theory of algebraic surfaces is presented and these problems are generalized to fields of characteristic p . The basic properties of rational transformations of algebraic varieties over an algebraically closed field are treated quite generally. A full proof of Bertini's theorem is given. Exceptional curves on an algebraic surface without singularities are discussed. The factorization theorem of anti-regular transformations into quadratic transformations is proved. The behavior of the canonical system of a surface with respect to birational transformations is discussed. It is found that the irreducible components of an exceptional curve of the first kind are non-singular curves. The theory of minimal models including the theorem of Néron and Severi concerning the behavior of the base number of algebraic divisors relative to birational transformations is used to prove that each birational class $\{F\}$ satisfies the minimum condition for the relation $<$. The approach used ultimately leads to a proof of Castelnuovo's theorem that a subfield of a rational function field $k(x,y)$ must be rational if k is algebraically closed and separable.

HAR.10:003

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

A FUNDAMENTAL INEQUALITY IN THE THEORY OF EXTENSIONS OF VALUATIONS, by I. S. Cohen and O. Zariski. [1957] [8]p. (AFOSR-TN-58-721) [AF 18(600)1503] AD 162256 Unclassified

Published in Illinois Jour. Math., v. 1: 1-8, Mar. 1957.

Let K be a field and let K^* be a finite algebraic extension of K , of degree n . Let v be a valuation of K , and let $v_1^*, v_2^*, \dots, v_g^*$ be the distinct extensions of v to K^* .

The following inequality is proven

$$\sum_{i=1}^g e_i f_i \leq n.$$

The value group and the residue field of v are denoted by Γ and Δ respectively, and the analogous entities for v_i^* are denoted by Γ_i^* and Δ_i^* . It is known that (a) the number g of distinct extensions v_i^* of v is finite, that

(b) Δ_i^* is a finite extension of Δ , and that (c) Γ is a subgroup of Γ_i^* of finite index. The integers $f_i = [\Delta_i^* : \Delta]$ and $e_i = \text{index of } \Gamma \text{ in } \Gamma_i^*$ are respectively the relative degree and the reduced ramification index of v_i^* with respect to v . To conclude the paper, some conditions are given under which the equality sign in the above equation is valid.

HAR.10:004

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON CASTELNUOVO'S CRITERION OF RATIONALITY $p_a = P_2 = 0$ OF AN ALGEBRAIC SURFACE, by O. Zariski. [1958] [13]p. [AF 18(600)1503] Unclassified

Published in Illinois Jour. Math., v. 2: 303-315, Sept. 1958.

Let F be a nonsingular (irreducible) algebraic surface over an algebraically closed ground field k . A theorem of Castelnuovo asserts that if the arithmetic genus p_a and the bigenus P_2 of F are both zero, then F is a rational surface. This theorem has been proved for fields k of arbitrary characteristic p , except in the case $(K^2) = 1$ where K is a canonical divisor on F . In the present paper proof is also given for the case $(K^2) = 1$. An immediate consequence of Castelnuovo's criterion of rationality is the well-known theorem of Castelnuovo on the rationality of plane involution. This theorem is stated as follows: Let $k(x, y)$ be a purely transcendental extension of an algebraically closed field k , of transcendence degree 2, and let Σ be a field between k and $k(x, y)$, also of transcendence degree 2 over k . If $k(x, y)$ is a separable extension of Σ , the Σ is a pure transcendental extension of k . It is shown in this paper by an example that the condition of separability of $k(x, y)/\Sigma$ is essential.

HAR.06:017

Harvard U. [Mallinckrodt Chemical Lab.] Cambridge, Mass.

SPECTROSCOPIC STUDIES OF SIMPLE SILICON COMPOUNDS, by M. K. Wilson. Final rept. Mar. 15, 1957 [21]p. incl. tables, refs. (AFOSR-TR-57-17) (AF 18(600)590) AD 120452; PB 127657 Unclassified

The spectra of many simple silicon, germanium, and tin compounds have been analyzed in some detail. This has led to a better understanding of the geometry of these molecules. Normal coordinate analyses have been made on the silanes, germanes, and fluorosilanes and a start has been made on ethane, disilane, and digermane.

HAR.07:054, 055; HAR.11:001, 002

HAR.07:054

Harvard U. Medical School. Biophysics Research Lab.,
Boston, Mass.

FLAME SPECTROMETRY, by B. L. Vallée. Nov. 1955
[26]p. incl. illus. diagrs. table, refs. (In cooperation
with Peter Bent Brigham Hospital, Boston, Mass.)
(Sponsored jointly by Office of Naval Research and [Air
Force Office of Scientific Research] under N5ori-07660)
Unclassified

Paper presented at Symposium on Trace Analysis, New
York, N. Y., Nov. 2-4, 1955.

Also published in Trace Analysis, J. H. Yoe, ed., John
Wiley and Sons, Inc., N. Y., 1957, p. 229-254.

The general principles of flame excitation and its ap-
plicability to spectrochemical analysis are reviewed.
Work on a direct-reading flame, which was constructed
in the biophysics research lab., is discussed. Research
on sources and mechanisms of excitation of radiating
species is also described. The phenomenon generally
referred to as "interference" is reviewed. (Contractor's abstract)

HAR.07:055

Harvard U. Medical School. Biophysics Research Lab.,
Boston, Mass.

SEPARATION, CONCENTRATION, AND CONTAMINA-
TION, by R. E. Thiers. [1957] [30]p. incl. illus. diagrs.
tables, refs. (In cooperation with Peter Bent Brigham
Hospital, Boston, Mass.) (Sponsored jointly by Office
of Naval Research and [Air Force Office of Scientific
Research] under N5ori-07660; continued by Nonr-
186604) Unclassified

Presented at Symposium on Trace Analysis, New
York, N. Y., Nov. 2-4, 1955.

Published in Trace Analysis, J. H. Yoe, ed., John
Wiley and Sons, Inc., N. Y., 1957, p. 637-666.

Methods of separation, concentration, and determination
for the millimicrogram range are reviewed. The prob-
lems associated with such methods are discussed,
solvent extraction and ion exchange being used as ex-
amples. Prevention of contamination is of obvious and
prime importance to this work. Some of the most
common sources of contamination are considered,
specific examples being used wherever possible. One
hundred seventy-seven references are cited covering a
time period from 1914 to 1955.

HAR.11:001

Harvard U. Medical School. Biophysics Research Lab.,
Boston, Mass.

THE SEQUENTIAL PROBABILITY RATIO TEST AP-
PLIED TO THE DESIGN OF CLINICAL EXPERIMENTS,
by A. F. Bartholomay. [1957] [8]p. incl. diagrs. tables.
(In cooperation with Peter Bent Brigham Hospital,
Boston, Mass.) (Sponsored jointly by Office of Naval
Research and [Air Force Office of Scientific Research
under Nonr-186604; continuation of N5ori-07660])
Unclassified

Published in New England Jour. Med., v. 256: 498-505,
Mar. 14, 1957.

A new procedure based on Wald's "sequential probability
test" is described which extends the applicability of
sequential analytical technique to clinical experiments.
When combined with classic statistical analysis in ad-
vance of the experiment, it allows the prediction of the
average number of observations that will be required
to validate or reject a given hypothesis. Once the ex-
periment is in progress, it furnishes a criterion for
the minimum number of observations needed to termi-
nate the experiment in a statistically significant manner.

HAR.11:002

Harvard U. Medical School. Biophysics Research Lab.,
Boston, Mass.

SPECTROPHOTOMETRIC EVIDENCE FOR ENZYME-
ZINC-INHIBITOR COMPLEXATION (Abstract), by B. L.
Vallée, T. L. Coombs, and R. J. P. Williams. [1957]
[1]p. (In cooperation with Peter Bent Brigham Hospital,
Boston, Mass.) [Sponsored jointly by Office of Naval
Research and Air Force Office of Scientific Research
under Nonr-186604] Unclassified

Presented at annual meeting of the Amer. Soc. of Biol.
Chemists, Chicago, Ill., Apr. 15-19, 1957.

Published in Fed. Proc., v. 16: 264, Mar. 1957.

The detection of zinc in several enzymes had led to the
proposition that this metal is functional in the reactions
catalyzed by these enzymes. This has been inferred
from data indicating the simultaneous aggregation of zinc
and of enzymatic activity during isolation of these en-
zymes, accompanied by the disappearance of other
metals. Chelating agents known to form complexes with
ionic zinc in aqueous systems have been employed to
inhibit enzymatic activity, and the kinetics of this inhi-
bition have been examined, particularly with 1,10-
phenanthroline. Such studies further imply an essential
role for zinc. 1,10-phenanthroline forms mono, bis,
and thermolecular complexes with zinc. Absorption
maxima at 3275 and 3425A have been found for these
systems. The extinction coefficients of the 3 molecular

HAR.11:003 - HAR.11:005

species at these 2 wavelengths have been calculated. The addition of 1,10-phenanthroline to various zinc-containing enzymes and zinc-insulin has demonstrated changes in absorption at 3275 and 3425A. The direct interaction of 1,10-phenanthroline with the protein-bound zinc has thus been demonstrated, simultaneously permitting the quantitative determination of the metal. The stoichiometric relationships of zinc, and 1,10-phenanthroline have been studied in these enzymes and correlated with the inhibition data. Spectrophotometric studies of zinc enzymes with other chelating agents also demonstrate changes characteristic of their ionic zinc systems. (Contractor's abstract)

HAR.11:003

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

SULFHYDRYL GROUPS, ZINC CHELATING INHIBITORS AND THEIR RELATIONSHIP TO THE ACTION OF YEAST ALCOHOL DEHYDROGENASE (Abstract), by F. L. Hoen and B. Zotos. [1957] [1]p. [In cooperation with Peter Bent Brigham Hospital, Boston, Mass.] [Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-186604] Unclassified

Presented at annual meeting of Amer. Soc. for Exper. Pathol., Chicago, Ill., Apr. 15-19, 1957.

Published in Fed. Proc., v. 16: 359-360, Mar. 1957.

The alcohol dehydrogenase of baker's yeast (YADH) has been shown to be a zinc metalloenzyme. A molecule of DPN and/or DPNH is bound to YADH at or near each of the 4 zinc atoms in the enzyme. Yeast ADH also contains sulfhydryl groups, and inhibition studies with specific reagents for -SH have been interpreted to indicate they are enzymatically active sites; no direct correlation between the analytical and the functional data is at hand. The significance of these findings for the explanation of the molecular basis of YADH action requires further study. YADH has been titrated with Ag⁺ alone and in the presence of metal binding agents. The number of -SH groups measured per molecule of enzyme is a critical function of the physical-chemical parameters of the system. The presence of a variety of chelating agents, however, does not change the number of titrable -SH groups at concentrations which inhibit enzyme activity. Similarly, the presence of DPN in a 10⁻⁵ molar excess does not alter titrable sulfhydryl content of the enzyme significantly. It may be concluded that the observed inhibition of YADH with metal binding agents is not due to their effects on -SH groups. (Contractor's abstract)

HAR.11:004

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

DISTRIBUTION OF METALS IN SUBCELLULAR FRACTIONS OF RAT LIVER, by R. E. Thiers and B. L. Vallee. [1957] [10]p. incl. diagrs. tables, refs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) (Sponsored jointly by Office of Naval Research and [Air Force Office of Scientific Research under Nonr-186604]) Unclassified

Published in Jour. Biol. Chem., v. 226: 911-920, June 1957.

Emission spectrography has been adapted to the simultaneous determination of a number of metals in subcellular fractions of normal rat livers. The pattern of metal distribution has been found characteristic and reproducible for each metal, and in one homogeneous rat population it does not vary with time. Iron and manganese have been found in complementary distribution. Sodium and potassium parallel one another. The metal content of the fractions correlates with present knowledge of the distribution of metalloenzymes. (Contractor's abstract)

HAR.11:005

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

ZINC METABOLISM IN POST-ALCOHOLIC CIRRHOSIS (Abstract), by B. L. Vallee, W. E. C. Wacker, and J. H. R. Kaegi. [1957] [1]p. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) [Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-186604] Unclassified

Presented at annual meeting of the Amer. Soc. Clin. Invest., Atlantic City, N. J., May 6, 1957.

Published in Jour. Clin. Invest., v. 36: 933, June 1957.

Iron in hemochromatosis and copper in Wilson's disease are implicated in the pathogenesis of these diseases, both of which ultimately lead to cirrhosis. Zinc, another transition-element, participates in the dehydrogenation of ethanol. This led to studies of zinc in post-alcoholic cirrhosis. In normal individuals ~ 500 µg per 24 hr of directly reacting zinc is excreted. Elimination of zinc in the urine apparently varies with the functional capacity of the post-alcoholic liver. "Zincuria" from 750 to 2,500 µg per hr has been observed in individuals with cirrhosis and hepatomegaly; apparently the first authenticated instance of primary "zincuria" without albuminuria. One terminal, jaundiced individual, however, with a small liver, ascites, serum-zinc 49 µg per cent, and BSP 61 per cent, excreted ~ 50 µg of zinc in 24 hr. Oral zinc induced transient changes in zinc excretion, and after

HAR.11:006 - HAR.11:008

ten days the BSP was 53 per cent. Another patient with marked hepatomegaly presented a different pattern: Serum-zinc was 77 μ g per cent, urinary zinc excretion was about 800 μ g per 24 hrs and the BSP was 32 per cent during the control period. Oral zinc abruptly decreased urinary zinc concentration to \sim 400 μ g per 24 hr. This level was maintained below the mean of the normal series throughout the experimental period. Serum-zinc rose to within normal limits. BSP was 10 per cent after ten days, remaining at this level. The participation of zinc in the dehydrogenation of ethanol, in the metabolism of post-alcoholic cirrhosis and the tendency of physiological quantities of zinc to restore normal biochemical patterns in the individuals studied emphasizes the unsuspected participation of this transition-element in another pathologic process, characterized by severe cicatrization in its terminal stages.

HAR.11:006

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

ZINC AND ITS BIOLOGICAL SIGNIFICANCE, by B. L. Vallee. [1957] [8]p. incl. refs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) [Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-186604]

Unclassified

Published in A. M. A. Arch. Indus. Health, v. 16: 147-154, Aug. 1957.

A review is presented of the biological significance of zinc. Physiological, biochemical, clinical, and toxicological implications are considered. Disturbances of zinc metabolism are noted in a variety of conditions. It is concluded, however, that detection of the latter cannot yet be assigned any decisive diagnostic role. A total of 28 domestic and foreign references are cited ranging in time from 1897 to 1956.

HAR.11:007

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

A CADMIUM PROTEIN FROM EQUINE KIDNEY CORTEX, by M. Margoshes and B. L. Vallee. [1957] [2]p. incl. table, refs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) [Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-186604]

Unclassified

Published in Jour. Amer. Chem. Soc., v. 79: 4813-4814, Sept. 3, 1957.

Fractionation of horse-kidney cortex with EtOH and $(\text{NH}_4)_2\text{SO}_4$ gave a product containing 20-5 mg/g dry

weight of cadmium in $\text{Cl}_3\text{CCO}_2\text{H}$ -precipitable material in successive fractionations. Ultracentrifugation in a synthetic-boundary cell showed the final products of 4 successive fractionations to be undispersed with a sedimentation (uncorrected for viscosity of diffusion)

varying from 0.94 to 1.22×10^{-13} . Paper electrophoresis at pH 8.5 of the product of 1 fractionation showed 3 components moving toward the cathode; the slowest comprised about 70% of the material. The Cd content rose 30-fold throughout the fractionation from the first extract to the product. Cd was not removable by dialysis at pH 7, but was removed by treatment with hot $\text{Cl}_3\text{CCO}_2\text{H}$. With the exception of Zn, other metals initially present or introduced during fractionation were removed and occurred in concentration in the final material. The possibility of isomorphism with Zn is discussed. The product contains 14% N, and reacts positively to ninhydrin and biuret. Hydrolysis and paper chromatography showed serine, glycine, aspartic and glutamic acids among other non-identifiable amino acids. The last fraction contained about 1% hexosamine.

HAR.11:008

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

A FINAL REPORT ON THE ACTIVITIES OF THE BIOPHYSICS RESEARCH LABORATORY UNDER CONTRACT NR 119-277 [N5ori-07660] Nonr 186604, by B. L. Vallee. Oct. 8, 1957 [23]p. incl. refs. (Sponsored jointly by Office of Naval Research [Air Force Office of Scientific Research, and Dept. of the Army] under Nonr-186604; continuation of N5ori-07660) AD 146515

Unclassified

The Biophysics Research Lab. of the Harvard U. Medical School and the Peter Bent Brigham Hospital was dedicated on May 17, 1954. The laboratory, which comprises an area of about 7,500 sq ft was completely remodeled within the existing facilities of the hospital. It has been fully equipped with all the instruments necessary for investigations in emission and absorption spectroscopy, intermediary metabolism and physical chemistry. It was established with major grants from the Rockefeller Foundation and National Institutes of Health. The first application to the Office of Naval Research was submitted in Apr. 1952 and a contract went into effect in 1953. The present report constitutes a review of activities, under this joint grant from the Navy, Army and Air Force, which was administered by the Office of Naval Research. Results of the work accomplished in the past years have been published in the scientific literature and is included in the bibliography. A brief resume of the work is listed as follows: Spectroscopy: Porous cup electrode sparking method; Noble gases and the dc arc; The direct-reading flame spectrometer; The cyanogen-oxygen flame; The coenzometer. Enzymology: Metalloenzymes; Kinetics:

HAR.11:009 - HAR.11:011

Mixed complexes; Other active groups; Cadmium protein; Electron transport in mitochondria; Metal content of subcellular fractions; Hibernation. Clinical Investigation: Copper in myocardial infarction; Lactic and malic dehydrogenase in myocardial infarction; Magnesium and acute renal failure; Zinc in cirrhosis. Mathematics: The sequential probability ratio test; Stochastic models. Analytical Chemistry: Determination of zinc (by means of methyl cellosolve and dithione); Zinc in urine; Concentration techniques; Contamination and separation.

HAR.11:009

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

ZINC METABOLISM IN HEPATIC DYSFUNCTION. II. CORRELATION OF METABOLIC PATTERNS WITH BIOCHEMICAL FINDINGS, by B. L. Vallee, W. E. C. Wacker, and A. F. Bartholomay. [1957] [11]p. incl. diagrs. tables, refs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) (Sponsored jointly by Office of Naval Research and [Air Force Office of Scientific Research under Nonr-186604]) Unclassified

Published in New England Jour. Med., v. 257: 1055-1065, Nov. 28, 1957.

Extension of previous studies demonstrated marked abnormalities of zinc metabolism in patients suffering from postalcoholic cirrhosis. In addition to markedly lowered concentrations of zinc in serum, this element is present in significantly lower concentrations in the liver tissue of such persons. Simultaneously, these patients excrete abnormally large quantities of zinc in their urine; a terminal patient, however, excreted subnormally low quantities of zinc. The administration of zinc sulfate in physiologic quantities tends to restore normal excretory patterns. The bromsulphalein retention in 5 patients with post-alcoholic cirrhosis tended toward normal in the course of these investigations on zinc metabolism. No attempts at specific therapy of the disease were undertaken. The data are interpreted in the light of the comparative biochemistry of zinc and ethanol metabolism. A conditioned zinc deficiency is conjectured to be consistent with the present data, and the known historical, pathophysiologic and pathobiochemical knowledge of this disease.

HAR.11:010

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

A STUDY OF MAGNESIUM METABOLISM IN ACUTE RENAL FAILURE EMPLOYING A MULTICHANNEL FLAME SPECTROMETER, by W. E. C. Wacker and B. L. Vallee. [1957] [9]p. incl. diagrs. tables, refs.

(In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) (Sponsored jointly by Office of Naval Research and [Air Force Office of Scientific Research under Nonr-186604]) Unclassified

Published in New England Jour. Med., v. 257: 1254-1262, Dec. 26, 1957.

The development of a simple, precise, and accurate flame spectrometric method for the determination of magnesium in serum made possible this study of magnesium metabolism in acute renal failure. The clinical pictures of magnesium intoxication and the uremic syndrome are similar. The severity of the potassium intoxication associated with acute renal failure does not always correlate with the serum concentration of this element. These facts led to an investigation of magnesium in the serum of patients with acute renal failure is significantly increased in all cases. In general, this elevation parallels that of potassium; in several patients, however, the elevation of magnesium is out of proportion to that of potassium. Owing to marked similarities of the electrocardiographic changes associated with hyperkalemia and hypermagnesemia, those due to hypermagnesemia are often mistaken for those of hyperkalemia. Changes in the electrocardiogram typical of hypermagnesemia were observed in these patients. One patient in this series had the signs of magnesium intoxication involving both the central nervous system and the heart. The electrocardiographic abnormalities disappear, and the serum magnesium concentration decreases with hemodialysis. These findings have an important bearing on the diagnosis and management of this syndrome which is accompanied by major disturbances in electrolyte metabolism. (Contractor's abstract)

HAR.11:011

Harvard U. Medical School. Biophysics Research Lab., Boston, Mass.

CONTAMINATION IN TRACE ELEMENT ANALYSIS AND ITS CONTROL, by R. E. Thiere. [1957] [63]p. incl. illue. diagrs. tables, refs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) [Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-186604] Unclassified

Published in Methods of Biochemical Analysis, v. 5, D. Glick, ed. Interscience Publishers, Inc., N. Y., 1957, p. 273-335.

The following topics are outlined in this review on contamination in trace element analysis and its control: (1) types of contamination; (2) manipulation of samples; (3) purification of reagents; (4) apparatus and equipment; (5) measurement of contamination; and (6) contamination in techniques of separation and concentration. Included are 197 foreign and domestic references covering a period of time from 1830 to 1957.

HAR. 11:012 - HAR. 11:015

HAR.11:012

Harvard U. Medical School. Biophysics Research Lab.,
Boston, Mass.

SPECTROPHOTOMETRIC EVIDENCE FOR ENZYME INHIBITOR COMPLEXATION, by B. L. Vallee, T. L. Coombs, and R. J. P. Williams. [1958] [5]p. incl. diagrs. refs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) (Sponsored jointly by Office of Naval Research and [Air Force Office of Scientific Research] under Nonr-186604) Unclassified

Published in Jour. Amer. Chem. Soc., v. 80: 397-401,
Jan. 20, 1958.

A mixture of ionic zinc and 1,10-phenanthroline demonstrates absorption maxima at 3125, 3275 and 3425A, in a special 5 cm absorption cell; these maxima have not been previously described. Addition of 1,10-phenanthroline or of 8-hydroxyquinoline-5-sulfonic acid to the zinc metalloenzymes, carboxypeptidase, yeast alcohol dehydrogenase or liver alcohol dehydrogenase, or to the zinc protein complex, insulin, produces ultraviolet absorption spectra, which are entirely analogous to those observed with the ionic zinc-1,10-phenanthroline or 8-hydroxyquinoline-5-sulfonic acid system. These spectra therefore demonstrate the existence of protein-zinc-chelate mixed complexes. Spectral evidence indicates these complexes to be completely dissociable upon dialysis. 1,10-phenanthroline and 8-hydroxyquinoline-5-sulfonic acid, previously shown to inhibit carboxypeptidase, yeast ADH and liver ADH, had been postulated to exert these inhibitory effects through interaction with the zinc atoms of the enzymes. The spectral data provide direct evidence for this proposed chemical interaction resulting in the formation of enzymatically inactive enzyme-zinc-chelator complexes. These findings offer additional evidence that zinc is an active site for these metalloenzymes and substantiate the previously proposed mechanisms for inhibition by metal chelators. (Contractor's abstract)

HAR.11:013

Harvard U. Medical School. Biophysics Research Lab.,
Boston, Mass.

THE ROLE OF ZINC IN ALCOHOL DEHYDROGENASES. II. THE KINETICS OF THE INSTANTANEOUS REVERSIBLE INHIBITION OF YEAST ALCOHOL DEHYDROGENASE BY 1,10-PHENANTHROLINE, by F. L. Hoch, R. J. P. Williams, and B. L. Vallee. [1958] [12]p. incl. diagrs. tables, refs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) (Sponsored jointly by Office of Naval Research and [Air Force Office of Scientific Research] under Nonr 186604) Unclassified

Published in Jour. Biol. Chem., v. 232: 453-464,
May 1958.

The kinetics of the instantaneous, reversible inhibition of yeast alcohol dehydrogenase (YADH) activity by a metal-binding agent, 1,10-phenanthroline (OP), have been investigated. One molecule of diphosphopyridine nucleotide or of reduced diphosphopyridine nucleotide competes with one molecule of OP, indicating that the coenzyme is bound to $[(YADH)Zn_4]$ at or near each of the zinc

atoms. Ethanol or acetaldehyde does not compete with OP, and the zinc atoms thus do not appear to be the chemical locus of a ternary complex. The inhibition data, together with a formulation of the reaction steps and a method for graphic solution, allow calculation of the velocity constants. The rate of dissociation of the enzyme-coenzyme complex appears to be a rate-limiting step. The formulation of YADH action in the light of these observed interactions with its zinc atoms is consistent with other data obtained without consideration of the metal as an active site. (Contractor's abstract)

HAR.11:014

Harvard U. Medical School. Biophysics Research Lab.,
Boston, Mass.

THE ROLE OF ZINC IN ALCOHOL DEHYDROGENASES. III. THE KINETICS OF A TIME-DEPENDENT INHIBITION OF YEAST ALCOHOL DEHYDROGENASE BY 1,10-PHENANTHROLINE, by R. J. P. Williams, F. L. Hoch, and B. L. Vallee. [1958] [10]p. incl. diagrs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) (Sponsored jointly by Office of Naval Research and [Air Force Office of Scientific Research] under Nonr-186604) Unclassified

Published in Jour. Biol. Chem., v. 232: 465-474,
May 1958.

The kinetics of the time-dependent, irreversible inhibition of yeast alcohol dehydrogenase by a metal-binding agent, 1,10-phenanthroline (OP), have been investigated. Under the stated conditions, the rate of inactivation is first order initially, when enzyme and OP are preincubated. A reaction scheme and a mechanism of inhibition are presented which fit the data. The instantaneous formation of a dissociable enzyme-inhibitor complex which contains 1 molecule of OP per active site appears to be the primary event. The subsequent slow addition of a 2nd molecule of OP to each site of enzymatic activity, forming a second complex by a process that is irreversible in an enzymatic sense, seems to account for the time-dependent inhibition. This type of inhibition may occur in other enzyme systems as well. (Contractor's abstract)

HAR.11:015

Harvard U. Medical School. Biophysics Research Lab.,
Boston, Mass.

HEB.01:001 - HEB.01:003

ZINC IN BEEF LIVER GLUTAMIC DEHYDROGENASE, by S. J. Adelstein and B. L. Vallee. [1958] [5]p. incl. diagrs. tables, refs. (In cooperation with Peter Bent Brigham Hospital, Boston, Mass.) (Sponsored jointly by Office of Naval Research and [Air Force Office of Scientific Research] under Nonr-186604)

Unclassified

Published in Jour. Biol. Chem., v. 233: 589-593, Sept. 1958.

Zinc is a constant constituent of crystalline beef liver glutamic dehydrogenase. Eight preparations contained between 2 and 4 gm atoms of zinc per mole of apoenzyme. The zinc concentration rises to a maximum value during the course of crystallization while the concentration of other metals falls to stoichiometrically negligible levels. The enzyme is inhibited by a number of reagents of differing chemical structure but capable of coordinating zinc. This inhibition is immediate and reversible by dilution or the addition of zinc ions to the reaction mixture. (Contractor's abstract)

Haverford Coll., Pa. see under Pennsylvania U., Philadelphia AF18(600)660, item no. PEN.01:006

HEB.01:001

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

SOME REMARKS ON TAUBERIAN THEOREMS, by A. Jakimovski. Jan. 1958, 27p. incl. refs. (Technical note no. 1) (AFOSR-TN-58-209) (AF 61(052)04) AD 154110

Unclassified

Also published in Quart. Jour. Math., v. 9: 114-131, June 1958.

Typical of the main results of this paper is the following theorem (stated here for sequences): Let $\{s_n\}$ be A -summable to s , and for some $\lambda < 1$, $M < 0$, and finite c ,

$$\liminf_n s_n = \min_{n < m \leq \lambda n} (s_m - Ms_n) > -c; \text{ then}$$

$$Ms - c \leq \liminf_n s_n \leq \frac{s+c}{M}, \text{ and } \{s_n\} \text{ is } (c,k)\text{-summable to } s \text{ for each } k > 0. \text{ If } (M-1)s < c, \text{ then } \lim_{n \rightarrow \infty} s_n = s.$$

The bounds on $\liminf_n s_n$ and $\limsup_n s_n$ are best possible.

The result is a specialization of a theorem on (L, α) -summability. $s(x)$ is (L, α) -summable to s for some fixed $\alpha > -1$ if

$s(x)$ is (L, α) -summable to s for some fixed $\alpha > -1$ if

$$L^\alpha(\tau) = \frac{\tau^{\alpha+1}}{\tau(\alpha+1)} \int_0^\tau s(t) t^\alpha e^{-\tau t} dt$$

exists for all $\tau > 0$ and approaches s as $\tau \downarrow 0$. The (L, α) method is regular, and it is shown that (L, β) -summability implies (L, α) -summability to the same sum for all α such that $\beta > \alpha > -1$. The use of non-absolutely convergent integrals here is a non-specious generalization. The iteration of the (L, α) method and the continuous Hausdorff transformation is also considered. (Math. Rev. abstract modified)

it implies (L, α) -summability to the same sum for all α such that $\beta > \alpha > -1$. The use of non-absolutely convergent integrals here is a non-specious generalization. The iteration of the (L, α) method and the continuous Hausdorff transformation is also considered. (Math. Rev. abstract modified)

HEB.01:002

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

EXTENSIONS, RETRACTIONS AND PROJECTIONS, by B. Grünbaum. Jan. 1958, 64p. incl. refs. (Technical note no. 2) (AFOSR-TN-58-210) (AF 61(052)04) AD 154111

Unclassified

An intermediate theory dealing with metric spaces and with operations restricted by conditions analogous to the boundedness of the norm of linear transformations is given. The concepts and quantitative aspects of Banach spaces theory, in combination with the generality and diversity of metric spaces develop a theory. By generalizing the results of Aronszajn-Panitchpakdi; the connection between "uniform" retractions and extensions of uniformly continuous functions with a subadditive modulus of continuity is established. Applicability to Banach spaces is shown and results and on the connection of projections with the extensions of linear operations are obtained. Also, a geometric property of the range-space is exhibited which characterizes the maximal increase of the norm or moduli of continuity for immediate extensions. This geometric property, the "expansion constant" of the space enables the investigation of extension properties (i.e. Banach spaces). Results are given and quantitative aspects of the extension problem for Minkowski spaces are discussed.

HEB.01:003

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

ON A THEOREM OF KIRSZBRAUN, by B. Grünbaum. Jan. 1958, 8p. (Technical note no. 3) (AFOSR-TN-58-401) (AF 61(052)04) AD 158203

Unclassified

Also published in Bull. Res. Council Israel, Sect. F 7: 129-132, 1957/58.

A proof is given for the following theorem: A real Banach space X has the extension property if and only if (1) either X is a unitary space, or (2) X is a 2-dimensional Minkowski space whose unit sphere is a parallelogram. The space X is said to have the extension property if for each function f , defined on a subset A of X , with values in a closed, convex subset $K \subset X$, there exists an extension F such that (i) $F(x) = f(x)$ for $x \in A$, (ii)

$F(x) \in K$ for $x \in X$, and (iii) $\|F\| = \|f\|$.

HEB.01:004 - HEB.01:009

HEB.01:004

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

ON A PROBLEM OF S. MAZUR, by B. Grünbaum. [1958] 5p. (Technical note no. 4) (Bound with its AFOSR-TN-58-401; AD 158203) (AF 61(052)04) Unclassified

Also published in Bull. Res. Council Israel, Sect. F 7: 133-135, 1957/58.

Proof is given for the non-existence of a 3-dimensional convex body K with a center O, such that any plane, centrally symmetric convex body C is affinely equivalent to the intersection of K with a suitable plane through O.

HEB.01:005

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

THE COERCIVENESS PROBLEM FOR INTEGRO-DIFFERENTIAL FORMS, by S. Agmon. May 1958, 72p. (Technical note no. 5) (AFOSR-TN-58-671) (AF 61(052)04) AD 162203; PB 136868 Unclassified

The solution of the problem of coerciveness for quadratic forms (not necessarily formally positive) over function classes defined by general boundary conditions is discussed. The general coerciveness theorem is given in which the bounded domains are considered for the sake of simplicity. A similar result holds for a wide class of unbounded domains. The general result depends on the corresponding coerciveness theorem in a half-space for forms with constant coefficients. This special case is further reduced, via the Fourier transform, to the problem of characterizing strongly coercive integro-differential forms with constant coefficients on the half-line. This method could be used to solve the general coerciveness problem for integro-differential quadratic forms over vector functions. (Contractor's abstract)

HEB.01:006

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

PROJECTION CONSTANTS, by B. Grünbaum. May 1958, 31p. incl. refs. (Technical note no. 6) (AFOSR-TN-58-672) (AF 61(052)04) AD 162204; PB 138978 Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 451-465, June 1960.

The projection constant P_X^* of a real Banach space X is defined as the greatest lower bound of all reals c having the property: for any normed space Y \subset X there exists a projection P: Y \rightarrow X such that $\|P\| \leq c$.

If $P_X^* = \min c$, P_X^* is called exact. Projection constants for a number of concrete spaces are determined. Bounds for other spaces are obtained as well as bounds of given concrete spaces for projections onto subspaces.

HEB.01:007

Hebrew U. Dept. of Mathematics, Jerusalem (Israel)

CLASSES OF MINIMAL AND REPRESENTATIVE DOMAINS AND THEIR BERGMAN KERNEL FUNCTION, by M. Maschler. May 1958, 37p. incl. diagrs. refs. (Technical note no. 7) (AFOSR-TN-58-673) (AF 61(052)04) AD 162205 Unclassified

Also published in Pacific Jour. Math., v. 9: 763-782, 1959.

A discussion is presented of "minimal domains" and "representative domains" with respect to certain subclasses of analytic functions, and solutions are deduced to some extremal problems. In addition, differential equations are obtained for the kernel function, which are valid for various classes of domains.

HEB.01:008

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

A GENERALIZATION OF THE LOTOTSKI METHOD OF SUMMABILITY, by A. Jaklmovski. June 1958, 29p. (Technical note no. 8) (AFOSR-TN-58-674) (AF 61(052)04) AD 162206; PB 136869 Unclassified

Also published in Mich. Math. Jour., v. 6: 277-290, 1959.

Many results proved for the Lototsky, or I., method of summability are valid for a general class of transformations to which the L transformation belongs. Given a sequence $\{d_n\}$, $n \geq 1$, d_n will denote the product

$d_1 d_2 \dots d_n$ and not as it sometimes denotes $\Gamma(d_n + 1)$.

$\{P_{nm}\}$, $m = 0, \pm 1, \pm 2, \dots$; $n = 0, 1, 2, \dots$, will denote the number defined by $P_{00} = 1$, $(x \cdot d_n) \mid =$

$\sum_{m=0}^n (x \cdot d_n) \cdot \frac{n}{m} P_{nm} x^m$, $P_{nm} = 0$ for $m > n$ and $n \neq 0$.
 $m=1$ $m=0$
 (ASTIA abstract)

HEB.01:009

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

RESEARCH IN THE AREA OF MATHEMATICAL ANALYSIS, by S. Agmon, E. Netanyahu and others. Final

HEB.02:001 - HEB.02:005

technical rept. July 1, 1957-Sept. 30, 1958. Dec. 1958, 33p. (AFOSR-TR-58-111) (AF 61(052)04) AD 210471
Unclassified

A report is presented of the research completed under this contract on the following topics: (1) Some remarks on Tauberian theorems; (2) Extensions, retractions and projections; (3) On a theorem of Kirzbraun; (4) On a problem of S. Mazur; (5) The coerciveness problem for integro-differential forms; (6) Classes of minimal and representative domains and their Bergman kernel function; and (7) A generalization of the Lototsky method of summability.

HEB.02:001

Hebrew U. Dept. of Physics, Jerusalem (Israel).

THE PARAMAGNETIC RESONANCE SPECTRUM OF GADOLINIUM IN HYDRATED LANTHANUM TRICHLORIDE, by M. Weger and W. Low. May 1958 [14]p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-58-543) (AF 61(052)59) AD 158360; PB 136996
Unclassified

Also published in Phys. Rev., v. 111: 1526-1528, Sept. 15, 1958.

The paramagnetic resonance spectrum of Gd^{3+} in $LaCl_3 \cdot 7H_2O$ has been measured at a frequency of 9373 mc at both room temperature and liquid air temperature. The observed lines have been fitted to a spin Hamiltonian involving b_2^0 , b_2^2 and b_4 terms by means of 3rd order perturbation for the b_2 terms and 1st order perturbation for the b_4 terms. No specific mechanism has been obtained for the line splitting, and the complex temperature dependence of the splitting indicates the possible existence of a number of mechanisms.

HEB.02:002

Hebrew U. Dept. of Physics, Jerusalem (Israel).

ELECTRON SPIN RESONANCE IN SINGLE CRYSTALS OF $BaTiO_3$, by W. Low and D. Shaltiel. May 1958 [8]p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-58-544) (AF 61(052)59) AD 158361; PB 136995
Unclassified

Also published in Phys. Rev. Letters, v. 1: 51-52, July 15, 1958.

The electron spin resonance of single crystals of $BaTiO_3$ has been observed at 3 cm in the ferroelectric phase. The angular dependence of the $(3/2, 1/2)$, $(1/2, -1/2)$ and $(-1/2, -3/2)$ transitions have been given for parallel and perpendicular orientations of the H field to the z axis.

HEB.02:003

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC RESONANCE AND OPTICAL SPECTRA OF SINGLE CRYSTAL OXIDES CONTAINING PARAMAGNETIC IMPURITIES, by W. Low. July 1958, 35p. incl. refs. (Technical note no. 3) (AFOSR-TN-53-882) (AF 61(052)59) AD 203906
Unclassified

Also published in Proc. Internat'l. Conf. on Solid State Physics in Electronics and Telecommunications, Brussels (Belgium) (June 2-7, 1958), N. Y., Academic Press, v. 3 (Part 1): 540-551, 1960.

A summary of the results of paramagnetic resonance spectra and optical spectra of single crystal oxides of cubic and lower symmetries containing paramagnetic impurities is presented. These results are discussed with reference to the possibility of using these materials for microwave amplification, Maser applications. A discussion is included of the effect of the Jahn-Teller theorem and the effects of covalent bonding on these spectra. (Contractor's abstract)

HEB.02:004

Hebrew U. Dept. of Physics, Jerusalem (Israel).

ELECTRON PARAMAGNETIC RESONANCE IN $BaTiO_3$, by W. Low and D. Shaltiel. [1958] [2]p. (AFOSR-TN-58-919) (AF 61(052)59) AD 234036
Unclassified

Also published in Phys. Rev. Letters, v. 1: 286, Oct. 15, 1958.

Further measurements of the electron paramagnetic resonance spectra of $BaTiO_3$ has revealed a number of points of disagreement with previously reported data. The value of S in the spin Hamiltonian is found to be 5/2 rather than 3/2. Crystals with a-domains have been found to have a spectrum which is 10 fold less intense than c-domain crystals. The role of the Fe^{3+} impurity has been investigated by means of doped samples which show the same spectrum but more intense than the pure samples used.

HEB.02:005

Hebrew U. Dept. of Physics, Jerusalem (Israel).

CALCULATION OF THE STABILIZATION ENERGY IN CRYSTAL FIELDS OF TETRAHEDRAL SYMMETRY, by W. Low. [1958] 3p. (AFOSR-TN-58-920) [AF 61(052)59] AD 204560
Unclassified

A brief argument is presented to show that the coupling between odd parity configurations introduces a perturbation in the Stark levels of the stabilization energy of

HEB.02:006; HRH.01:001-003

cations in octahedral and tetrahedral crystal field configurations. It is concluded that an error up to 50% is inherent in previous calculations of the tetrahedral stabilization energy and that the agreement with experiment of the cation distribution calculated is fortuitous.

HEB.02:006

Hebrew U. Dept. of Physics, Jerusalem (Israel).

THE OPTICAL SPECTRUM OF Co^{2+} IN THE CUBIC CRYSTALLINE FIELD OF CaF_2 , by R. Stahl-Brada and W. Low. July 1958 [23]p. incl. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-58-1036) (AF 61-052)59 AD 206485 Unclassified

Also published in Phys. Rev., v. 113: 775-780, Feb. 1, 1959.

The optical spectrum of Co^{2+} in CaF_2 has been analyzed, and absorption bands are found at 3μ , 1.5μ and $550\text{m}\mu$ which show fine structure. In addition there are weak and narrower bands at 19,220, 19,580, 20,450, 21,750, 22,000, 25,750 and intense lines at 44,250, 48,200 cm^{-1} . The spectrum is interpreted to arise from transitions from the orbital singlet to various Stark levels split by spin-orbit interaction, and yields values of $Dq = 340 \pm 10 \text{ cm}^{-1}$, $E(P) = 14,000 \pm 100 \text{ cm}^{-1}$, $E(G) = 16,250 \pm 100 \text{ cm}^{-1}$. The spectrum of Co^{2+} in the eight coordinated cubic symmetry is compared with Co^{2+} in octahedral and tetrahedral symmetry as well as with Cr^{3+} in octahedral symmetry. (Contractor's abstract)

HRH.01:001

Henri-Rousselle Hospital, Paris (France).

[EXPERIMENTAL STUDY OF RETICULO-CORTICAL INTERRELATIONSHIPS. PROPOSAL FOR A THEORY OF THE SERVO-CONTROL OF THE RETICULAR ACTIVITY BY A DIFFUSE CORTICAL SYSTEM] Étude expérimentale des interrelations réticulo-corticales. Proposition d'une théorie de l'asservissement réticulaire à un système diffus cortical, by A. Hugelin and M. Bonvallet. [1957] [23]p. incl. diagrs. (AFOSR-TN-58-539) (AF 61(514)1100) AD 158355 Unclassified

Also published in Jour. Physiol. (Paris), v. 49: 1201-1223, 1957.

An attempt was made to determine (1) the existence of a single system in which the facilitatory descending reticular discharge as well as the ascending reticular discharges take their origin; and (2) if the inhibitory descending impulses evoked by the ascending reticular

discharge reach directly the motoneurons, or whether they inhibit the activated reticular system itself. A comparison of the corticogram and the excitability of motoneurons show that (1) during repetitive stimulations (sudden onset) of the reticular formation under constant voltage, the 2 types of activities are controlled simultaneously but not equally; and (2) in the "encéphale isolé," when the repetitive stimulations are established progressively, the excitability of motoneurons did not seem to be modified. (ASTIA abstract)

HRH.01:002

Henri-Rousselle Hospital, Paris (France).

[ANALYSIS OF RETICULAR AND CORTICAL POST-DISCHARGES FOLLOWING ELECTRICAL RETICULAR STIMULATION] Analyse des post-décharges réticulaires et corticales. Engendrées par des stimulations électriques réticulaires, by A. Hugelin and M. Bonvallet. [1957] [10]p. incl. diagrs. table. (AFOSR-TN-58-540) (AF 61(514)1100) AD 158356; PB 140329 Unclassified

Also published in Jour. Physiol. (Paris), v. 49: 1225-1234, 1957.

Effects of reticular post-discharges: In an animal with an anatomically intact cortex but with its inhibitory cortical system blocked by administration of a dose of chloralose, the reticular post-discharge lasted about 10 times more than in the diencephalic animal. In non-aeschetized animals, the cortical influence which enhances the reticular activity seemed to be concealed by the power of the corticifugal inhibition. The motor effects of the reticular post-discharge were about 100 times shorter in the "encéphale isolé" than in the chloralosed animal. Effects of cortical post-discharge: A cortical servomechanism theory is discussed which describes the reticular net as one functional unit which, when put into action, acts as a whole and produces an output of indifferential ascending and descending impulses. (ASTIA abstract)

HRH.01:003

Henri-Rousselle Hospital, Paris (France).

[CORTICAL TONUS AND CONTROL OF THE MOTOR FACILITATION OF RETICULAR ORIGIN] Tonus cortical et contrôle de la facilitation motrice d'origine réticulaire, by A. Hugelin and M. Bonvallet. [1957] [30]p. incl. diagrs. refs. (AFOSR-TN-58-541) (AF 61-514)1100 AD 158357 Unclassified

Also published in Jour. Physiol. (Paris), v. 49: 1171-1200, 1957.

HER. 03:001; HIL. 01:001; HOR. 03:001

Experiments were conducted to demonstrate that (1) the diffuse inhibitory cortical system has normally a continuous tonic activity which is in opposition to that of the reticular facilitatory system; and (2) the variations of intensity of this inhibitory tonus are directly dependent on the fluctuations of the general excitatory state of the cortex. In spinalized unanesthetized preparations a prebulbar electrical reticular preparation elicited the classical motor facilitation which is controlled at once by an inhibition which brings back the motoneuron excitability to initial level or lower. This inhibition originated in the neocortex. The bilateral and diffuse origin of the inhibition was demonstrated by the unsuccessful attempts to block it by localized cortical coolings. The descending pathways of this inhibition are extrapyramidal. A supra-bulbar transection of the brain stem did not change the cortical inhibitory control of reticular motor facilitation. The simultaneous recording of EEG and the masseter reflex showed that the motor facilitation always coincided with a cortical arousal, and that the cortex-originated inhibition was always secondary to it. In the absence of reticular stimulation the diffuse cortical inhibitory system displayed a permanent activity, the intensity of which was conditioned by the cortical tonus. At sensory rest this corticofugal inhibitory tonus equalized the reticular facilitatory tonus. (ASTIA abstract)

HER.03:001

Hermann Föttinger Inst. für Strömungstechnik,
Technische Universität, Berlin-Charlottenburg
(Germany).

FURTHER INVESTIGATIONS OF THE LAMINAR-TURBULENT TRANSITION IN A FREE JET (ANNULAR NOZZLE), by O. Wehrmann and H. Fabian. Final rept. Dec. 1956, 44p. incl. diagrs. tables, refs. (AFOSR-TR-57-31) (AF 61(514)915) AD 126494 Unclassified

The experimental results and theoretical considerations reported here are a continuation of earlier investigations devoted to the problem of laminar-turbulent transition in a free jet. The fact, that consecutive ring vortices and their mutual interaction govern the local transition range in the free boundary of a circular jet, could be substantiated by improved hot-wire techniques. The law, governing the shedding frequency of the ring vortices as function of the Reynolds number, has been inspected closely, and an influence of the nozzle boundary layer had been found. Most emphasis has been laid on the detailed investigation of the vortex structure of the jet boundary. By application of a special calibration method it has been possible to measure the velocity distribution of the vortices numerically and to determine with rather good accuracy the value of a critical vortex Reynolds number which describes the final stage of a vortex before its three dimensional decay. In all these investigations three types of nozzles have been used: rounded nozzles of various diameters, a sharp-edged orifice, and an annular nozzle with a solid core at its center. In all three cases the frequency law and the

transition phenomena show the same characteristics. In the last chapter of this report first stages of a new series of experiments are described. The problem in question is the acoustic control of the transition phenomena. It could be proved that sound waves of low energy cannot only stabilize the vortex shedding but moreover can vary the shedding frequency in a limited range. Some analogies to the well known transition criteria of the first plate boundary layer are pointed out. (Contractor's abstract)

HIL.01:001

Hiller Helicopters. Advanced Research Div., Palo Alto, Calif.

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THE FEASIBILITY OF PRODUCING STATIC LIFT BY VORTEX MOTION, by R. M. Lockwood. Technical summary rept. Jan. 14, 1958, 1v. incl. illus. diagrs. refs. (Rept. no. 178) (AFOSR-TR-58-16) (AF 49(638)-171) AD 148115 Unclassified

A broad preliminary investigation has been conducted to determine if it is feasible to create static lift in air with small-scale cyclonic vortex motion. A survey of the literature and a variety of experiments with simple equipment were conducted. On the basis of this work a revised description of the fundamentals of cyclonic vortex motion is made, which also suggests some reasons why this motion occurs. The conclusions are as follows: (1) Cyclonic vortices have been formed between paired suction drains with counterrotating circular flow around them. (2) It should be possible to derive some lift from an arrangement like the preceding one, but magnitudes have not yet been determined. (3) It does not appear to be feasible to induce a cyclonic vortex in air over a single drain which is unenclosed (i.e., completely open to the atmosphere). (4) There is a possibility that half-ring vortices may be created by means of intermittent jets. (5) The passage of the ends of a half-ring vortex across a surface might induce a pressure differential on that surface. (Contractor's abstract)

HOR.03:001

Horizons, Inc., Cleveland, Ohio.

INVESTIGATION OF THE CORROSIVE COMPONENT OF MECHANICAL WEAR, by R. H. Baakey. Final progress rept. May 1, 1958, 100p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-73) (AF 18(600)1589) AD 158313; PB 135624 Unclassified

Measurements were made of the corrosive wear on sliding steel surfaces as a function of load, distance of travel, and frequency of rotation past a given area in such a manner that the effects of adhesion and abrasion of the base metal were eliminated. The corrosive wear

HOR.04:001 - HOR.04:003

varied linearly with the distance of the travel. There were loads below 20,000 g/sq cm where the amount of corrosive wear was negligible. Above this figure, the wear varied linearly with the load until the mating surfaces broke completely through the oxide film to initiate a type of fretting corrosion. Up to 75 cm/sec the volume of wear products for steel running against steel, where an oxidized film is formed on each surface, varied closely with the equation $V = k WL \ln([1/f\tau] + 1)$, where k and τ are constants, W is the load, and L is the distance traveled. As the frequency increased, the wear volume increased. Oxidation depended on the time interval, temperature of asperities, oxygen present, and ambient temperatures. The amount of wear depending on corrosive wear decreased due to a decreasing time interval. When rubbing brass against an oxidized iron film frequency had an effect similar to that found for steel against steel. It was not possible to measure the oxidation of Al by knoop impressions because the Al_2O_3

oxide particles erode the soft base Al. Increasing the temperatures from 40° to 200°F gave an increase in the volume of wear up to 72°F, remained constant from 72° to 150°F, and increased up to 200°F.

HOR.04:001

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

CRYSTALLOGRAPHIC AND MAGNETOCHEMICAL STUDIES ON ABO_3 GROUP COMPOUNDS OF

LANTHANON AND MANGANESE OXIDES, by R. C. Vickery and A. Klann. Mar. 1, 1957, 7p. incl. tables. (Technical note no. 1) (AFOSR-TN-57-122) (AF 18-603)96 AD 120477 Unclassified

Also published in Jour. Chem. Phys., v. 27: 1161-1163, Nov. 1957.

The three rare earths studied were Pr, Nd and Dy. A Gouy magnetic balance was used for all magnetic measurements. Samples were formed by firing at both 900°C and 1200°C. The observed susceptibilities were compared with the expected values by addition of the component values. All the products showed an enhanced susceptibility of 55 to 175% above additive component values. The firing of the samples had a greater effect on the Nd systems than the others. The Pr systems showed the greatest increase in susceptibility. From this it is concluded that there is alignment of the magnetic moments not only of the 3-d and 5-d shells but also hybridization of the 4-f electrons of the lanthanon ions. X-ray evidence showed little compound formation at 900°C; but, after two hours treatment at 1200°C, the perovskite pattern could be identified and was apparently stabilized after 20 hr firing.

HOR.04:002

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

MAGNETIC SUSCEPTIBILITIES OF ORTHO AND META VANADATES OF NEODYMIUM AND PRASEODYMIUM, by R. C. Vickery and A. Klann. Mar. 1, 1957, 4p. incl. table. (Technical note no. 2) (AFOSR-TN-57-123) (AF 18(603)96) AD 120478 Unclassified

Also published in Jour. Chem. Phys., v. 27: 1219-1220, Dec. 1957.

The ortho vanadates of Nd and Pr were found to have tetragonal unit-cells with $a_0 = 7.30$ Å and $c_0 = 6.45$ Å. The meta vanadates were found to have cubic perovskite structures with unit-cells of edge length 3.90 Å. The Nd vanadates had observed susceptibilities which were the same as the additive values of their components. The Pr vanadates showed a marked increase in their observed susceptibilities. It was concluded that this increase was due to the multivalent character of both the metal ions. In these cases Heisenberg exchange effects are expected to be important.

HOR.04:003

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

PREPARATION AND MAGNETIC PROPERTIES OF PYROCHLORE-TYPE TITANATES OF NEODYMIUM AND PRASEODYMIUM, by R. C. Vickery and A. Klann. Mar. 1, 1957, 3p. incl. table. (Technical note no. 3) (AFOSR-TN-57-124) (AF 18(603)96) AD 120479 PB 126935 Unclassified

Also published in Jour. Chem. Phys., v. 27: 1220-1221, Dec. 1957.

The x-ray patterns of $Pr_2Ti_2O_7$ and $Nd_2Ti_2O_7$ confirm

Roth's theory that oxides of the largest A^{3+} ions with tetravalent ions give distorted pyrochlore structures, whereas slightly smaller A^{3+} ions form cubic pyrochlore compounds. X-ray diffraction shows that compounds formed at 900°C are simply oxide mixtures, but compounds formed at 1200°C are pyrochlore structures. Susceptibility measurements also confirm this statement. The ratio of Ti to the lanthanon has little effect on the x-ray properties of the products. However the perovskite lattice can be changed to a pyrochlore lattice by the addition of a lanthanon oxide. The magnetic susceptibility of this pyrochlore system is largest when the ratio is 1 to 2.3. The Pr systems exhibited larger observed susceptibilities than the additive values of their components.

HOR. 04:004; HOR. 05:001-003

HOR.04:004

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

MAGNETIC SUSCEPTIBILITIES OF PRASEODYMIUM AND TERBIUM OXIDES, by R. C. Vickery and A. Ruben. May 1, 1958, 11p. incl. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-58-292) (AF 18(603)96) AD 154197; PB 135263 Unclassified

The x-ray powder diffraction patterns at room temperature and the magnetic susceptibilities in a temperature range from liquid nitrogen to 600°K have been measured for the three oxides of praseodymium - Pr_2O_3 ,

Pr_6O_{11} , and PrO_2 - and the three oxides of terbium - Tb_2O_3 , Tb_4O_7 , and Tb_6O_{11} . The measured values of the magnetic moments are in good agreement with theoretical expectations and the Curie-Weiss law up to 300°K. Above this temperature the temperature-susceptibility curve shows a sharp change in slope and would yield considerably lower magnetic moments if extrapolated.

HOR.05:001

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

AN UNUSUAL FORM OF NEODYMIUM SILICATE, by R. C. Vickery and R. Sedlacek. [July 1, 1957] 4p. incl. illus. [Technical note no. 1] (AFOSR-TN-57-317) (Also bound as Appendix I with its AFOSR-TR-57-86; AD 136676)(AF 48(638)5) AD 132388 Unclassified

Also published in Research, v. 10: 371-372, Sept. 1957.

An unusual form of neodymium silicate was observed in the preparation of a simple, Pb-based glass. Microscopic examination of undissolved residues of Nd_2O_3 showed that the blobs of oxide acted as foci for the development of rosettes of needle-like crystals. Attempts to isolate these crystals for analysis showed that they were unattacked by warm HF , H_2SO_4 , HCl , HNO_3 , and concentrated alkalis. The resistance to HF attack was such that the surrounding glass matrix could be etched away, leaving the crystals in relief above the etched background. Some spicules of these crystals were shown by qualitative microanalysis to contain only Nd and SiO_2 ; tests for Pb by the dithizone reaction gave negative results. It was not possible to determine crystal angles on the specimens obtained, but they were observed to be anisotropic, extinguishing at 90° under polarized light.

HOR.05:002

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

EFFECTS OF LOW CONCENTRATIONS OF RARE

EARTH OXIDES UPON REFRACTIVE INDEX AND DENSITY OF A LEAD GLASS, by R. C. Vickery and R. Sedlacek. July 1, 1957, 10p. incl. diag. tables. (Technical note no. 2) (AFOSR-TN-57-318) (AF 49(638)5) AD 132389 Unclassified

Density and refractive-index observations were made of PbSiO_3 glasses containing relatively low concentrations (0.1 to 2.0%) of rare-earth oxides. The base glass was equivalent to Corning 0120. In general, the density and refractive-index measurements reciprocated each other; a general form of graphical plot is shown. From the plot, a correlation of effect is noted with passage through the rare-earth series in that the inclusion of heavy earths, of ionic size smaller than the light group, produced an initial drop in density and refractive index before increasing values for these parameters. The lighter earths generally increased both density and refractive index. Where ionic size is appropriate, i.e., up to ca. 1.1 Å radius, the ion will insert within the PbSiO_3 lattice.

This, being already strongly polarized, will develop a further deformation and repulsion effect which leads to ionic repulsion and expansion of the lattice to the point of maximum stress before breaking down to form a 3-dimensional polyhedral network that involves the rare earths in silicate structures. The introduction of La into the glass produced density and refractivity data plots analogous to those of the heavy earths, i.e., an initial dip and then an increase; Sc adopted a data plot similar to that of the heavy earths. Within the heavy lanthanon group, a certain sequence in plot may be observed, the nadir shifting to lower concentrations of rare earths as ionic size increases.

HOR.05:003

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

RARE EARTHS IN GLASS SYSTEMS, by R. C. Vickery and R. Sedlacek. Technical rept. Oct. 1, 1956-Sept. 30, 1957. Oct. 30, 1957, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TR-57-86) (AF 49(638)5) AD 136676 Unclassified

The effect upon density and refractive index has been studied of the inclusion of low concentrations of rare-earth ions in lead silicate, soda-lime, and phosphate glass matrices. Rare-earth concentrations of up to approximately 2 atomic % have no appreciable effect upon refractive indices, but a significant change is noted in density values. Such changes present particularly noticeable trends in phosphate glasses; these trends are observable also to a certain degree in soda-lime glasses, but less noticeable in lead glasses. It is considered that the variable function of the Pb^{2+} ion obscures the general effect of rare earths in lead silicate glasses; but in soda-lime, and more specifically in phosphate glasses, evidence is highly satisfactory that the lanthanons (La - Lu) function only as network

HOR. 05:004; HOR. 06:001-003

modifiers, but that scandium and yttrium in concentration > 0.2 and 1.0 atomic % function strongly as network formers. This is shown to be in accord with concepts associating glass function with cation electronegativity. Observations are also presented on the formation of a neodymium silicate, resistant to hydrofluoric acid; on shifts and dissection of neodymium and praseodymium absorption spectra in phosphate glasses; and on fluorescence of glasses containing samarium, europium, and ytterbium. (Contractor's abstract)

HOR.05:004

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

ABSORPTION SPECTRA OF RARE EARTHS IN GLASSES, by R. C. Vickery and R. Sedlacek. [1957] 4p. incl. illus. (Bound as Appendix II with its AFOSR-TR-57-86; AD 136676) (AF 49(638)5) AD 136676(a)
Unclassified

Also published in *Nature*, v. 181: 39-40, Jan. 4, 1958.

In initiating research on the effect upon physical properties of rare earths in glasses, the absorption spectra of a phosphate glass (Corning 4600) containing varying concentrations of rare earths have been examined. Contrary to earlier data, dissection and wavelength shift occur for certain neodymium and praseodymium absorption bands while the Pr bands also decrease in intensity. This evidence strongly indicates the existence of complex ions of the type $[Ln(PO_4)_x]$ in phosphate environments.

HOR.06:001

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

STUDIES ON RARE EARTH CARBIDES. I, by R. C. Vickery, R. Sedlacek and A. Ruben. Jan. 2, 1958, 15p. incl. tables, refs. (Technical note no. 1) (AFOSR-TN-58-38) (AF 49(638)80) AD 148079; PB 137000
Unclassified

Also published in *Jour. Chem. Soc. (London)*, No. 103: 498-503, Feb. 1959.

The synthesis and some properties of the higher carbides of some rare earths are reported. The reaction investigated is that between rare earth oxides and carbon at high temperatures and under low pressures of argon. Carbide formation proceeds via metal production, and interstitial compounds can exist of rare earth metal held in the carbide lattice. The higher carbides (LnC_2) adopt a tetragonal structure, but scandium differs

from the lanthanons and yttrium in forming only a hexagonal monocarbide (ScC); this is basically attributed to the small size of the scandium ion which sterically per-

mits its association with only one carbon atom. (Contractor's abstract, modified)

HOR.06:002

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

STUDIES ON RARE CARBIDES. III, by R. C. Vickery, R. Sedlacek, and A. Ruben. July 17, 1958, 12p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-58-593) (AF 49(638)80) AD 162117; PB 136994
Unclassified

Also published in *Jour. Chem. Soc. (London)*, No. 105: 505-510, Feb. 1959. (Title varies)

K-edge adsorption of some rare-earth carbides has been studied in further attempts to rationalize the structure of these compounds. The attainment of bivalent states in samarium and ytterbium carbides receives further confirmation, whilst from consideration of energy values the "free electron" concept appears substantiated. (Contractor's abstract)

HOR.06:003

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio

STUDIES ON RARE CARBIDES. II, by R. C. Vickery, R. Sedlacek and A. Ruben. July 17, 1958, 7p. incl. diagrs. table. (Technical note no. 2) (AFOSR-TN-58-594) (AF 49(638)80) AD 162118; PB 138751
Unclassified

Also published in *Jour. Chem. Soc. (London)*, No. 104: 503-505, Feb. 1959. (Title varies)

The intrinsic paramagnetism of trivalent rare earth ions is shown to be affected only to a minor degree upon carbide formation. Except for samarium and ytterbium carbides, the small negative difference noted between theoretical and observed magnetism is attributed to partial spin coupling or quenching of the orbital angular moments. As carbides, samarium and ytterbium are considered to adopt their bivalent states. Bohr magneton numbers and Curie-Weiss constants are presented for the carbides studied. (Contractor's abstract)

Hormel Inst., Austin Minn. see Minnesota U. Hormel Inst., Austin Minn.

IIT. 03:002; IIT. 04:006;
IIT. 08:001; IIT. 09:001

IIT.03:002

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

A STUDY OF A FAMILY OF LAVES-TYPE INTER-MEDIATE PHASES, by R. P. Elliott. Final rept. Mar. 15, 1955-May 14, 1956. Jan. 18, 1957, 18p. incl. diagrs. tables. (AFOSR-TR-57-12) (AF 18(600)1399; continued by AF 18(603)130) AD 120421 Unclassified

Paramagnetic susceptibility measurements were made on binary and ternary Laves-type phases of constant atomic proportions of titanium and zirconium. Comparison of the susceptibilities of the binary compounds with the susceptibilities of the component elements indicates that the free electrons of the components are contributed directly to the compound lattice. Measurements of the ternary alloy susceptibilities indicate a nonlinear function with composition. This is indicative of a complex density of states vs energy curve precluding direct calculation of the component valencies. Paramagnetic trends of binary and ternary Laves compounds offer further proof that the free electron valency of the elements of the first transition series decreases as atomic number increases. (Contractor's abstract)

IIT.04:006

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

A NEW METHOD FOR MEASURING INTEGRATED INTENSITIES PHOTOGRAPHICALLY, by L. V. Azaroff. [1957] [5]p. incl. illus. diagrs. [AF 18(600)1168] Unclassified

Published in Acta Crystallographica, v. 10: 413-417, June 10, 1957.

A bent-crystal monochromator is used in conjunction with a conventional Buerger precession camera. Each reflection intensity is recorded on the film as a rectangular spot having nearly constant intensity across the long direction and a narrow plateau across the short direction. The integrated intensity is obtained by direct measurement of the height of this plateau with a densitometer. The use of crystal monochromatized x-radiation permits the recording of the direct beam on the same film and the determination of the absolute value of each intensity. The use of crystal monochromatized x-radiation also permits increased exposure times to detect weak intensities owing to the very low background intensity. The accuracy of this method has been tested with a CaF_2 crystal and the agreement between observed and measured structure factors was better than 2%. (Contractor's abstract)

IIT.08:001

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

X-RAY ABSORPTIMETRY IN SYSTEMS OF LIGHT ELEMENTS, by D. Greenberg. Final rept. Dec. 1, 1955-Nov. 30, 1956. Feb. 6, 1957, 30p. incl. illus. diagrs. tables. (AFOSR-TR-57-13) (AF 18(600)1563) AD 120423 Unclassified

A proposed non-destructive quantitative analytical technique for determining the per cent composition of compounds composed of light elements which utilized the properties of the x-ray absorption coefficients of these elements has been investigated. The method involves determining the absorption by the unknown of monochromatic x-rays at several different wavelengths, and the subsequent solution of a series of simultaneous linear equations which yields directly the densities of the elements under consideration in the unknown compound. Detailed descriptions are given of the apparatus used to obtain fairly intense collimated monochromatic x-ray beams by fluorescence excitation, as well as of the x-ray detection system. Data is presented to illustrate the stability and reproducibility of the apparatus, and experimental results are given that support the feasibility and applicability of the method. Suggestions are made whereby the precision of the instrument could be improved in subsequent laboratory prototypes. (Contractor's abstract)

IIT.09:001

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

INVESTIGATION OF ELECTROMAGNETIC LAUNCHERS FOR HIGH-SPEED PROJECTILES, by K. W. Miller, R. M. Bergslien and others. Quarterly rept. no. 3, Oct. 1, 1956-Dec. 31, 1956. Jan. 18, 1957, 38p. incl. diagrs. appendices. (AFOSR-TN-57-229) (AF 18(603)56) AD 119535 Unclassified

Work has continued during the past quarter on the phenomena which may be expected to occur in and near the crossbar and under the sliding electric contact type electromagnetic launchers. Skin effect and proximity effect are shown to be appreciable with important but not extremely undesirable results by: increasing resistance voltage drop and losses, decreasing inductance or bar driving force, increasing force of repulsion between rails, causing non-uniform pinch effect, and increasing heating under the sliding electrical contact. This last result is most serious, skin effect surface heat combining with probable local parasitic currents to increase temperature otherwise expected due to friction, contact voltage drop, arcing and other heat producing causes. A long slender crossbar is advantageous and perhaps a longitudinally laminated rail surface

IIIT.09:002 - IIIT.09:004

may be required to improve operation of the sliding contact. The following appendices are included: Appendix A - Transient Skin, Proximity, Pinch, Repulsion and Temperature Effects in Rails; Appendix B - Diffusion of Electric Current into Rods, Tubes, and Flat Surfaces; and Appendix C - Parasitic Currents at Sliding Contacts.

IIIT.09:002

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

STUDY OF ELECTROMAGNETIC GUN, by K. W. Miller and R. M. Bergslien. July 1957, 43p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-57-244) (AF 16-603)56) AD 126541 Unclassified

Also published in Proc. Second Hypervelocity and Impact Effect Symposium, Naval Research Lab., Washington, D. C. (May 22-24, 1957), Washington, Naval Research Lab., v. 1: 127-151, Dec. 1957.

A general review is presented of the field of electromagnetic accelerators for high speed projectiles. All three of the basic electromagnetic gun types - Induction solenoid, repulsion coil and parallel rail d-c gun - involve difficult problems which must be resolved. A major problem inherent to all types is that enormous amounts of electric energy are required to accelerate even relatively small masses to hypervelocities. Electromagnetic energy converters in the form of the homopolar generator and inverse electric gun and capacitive and inductive storage devices offer some promise. However, at the present time no conclusion can be made as to the best possible source. Other problems inherent in all gun types are mechanical and aerodynamic friction, skin and proximity effects, large magnetic forces, and definite thermal limitations. The induction and repulsion type guns involve very serious timing problems, while the parallel rail d-c gun involves a complex sliding contact problem. The comparative merits and limitations of the three types of guns require further theoretical and experimental analysis to choose among them. (Contractor's abstract)

IIIT.09:003

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

ELECTROMAGNETIC ACCELERATION OF HIGH-SPEED PROJECTILES, Aug. 1957, 1p. (AFOSR-TN-57-547) (In its 1957 Annual rept., p. 28) (AF 16(603)56) Unclassified

To study ablation and impact problems associated with high-altitude aircraft and missiles, the Air Force requires means for accelerating pellets to extremely high velocities. The Air Force Office of Scientific Research

placed a project with the Foundation to study the application of electromagnetic principles to the design of a high-velocity accelerator. The goal is to achieve velocities in the order of 25,000 to 35,000 ft/sec with pellets of controlled shape, mass, and material. Part of this velocity range is higher than the escape velocity from the earth. Acceleration by electromagnetic means, such as is used in conventional electric motors, may not be subject to as low theoretical limitations as other methods presently used for obtaining high velocities. This project involves theoretical and experimental investigation of the phenomena and limitations associated with high-speed electromagnetic accelerators. A small-scale electromagnetic accelerator is currently being constructed. (Contractor's abstract)

IIIT.09:004

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

INVESTIGATION OF ELECTROMAGNETIC LAUNCHER FOR HIGH-SPEED PROJECTILES, by J. L. Radnik and A. Bak. Final rept. May 1958, 67p. incl. illus. diagrs. tables. (AFOSR-TR-58-84) (AF 16(603)56) AD 158393; PB 135363 Unclassified

The design and performance characteristics of a parallel rail electromagnetic accelerator were studied to determine the feasibility of the linear motor accelerator as a research tool capable of accelerating small particles to velocities of 25,000 ft/sec and above. The program consisted of a study of the basic electromechanical relationships, a study of suitable energy sources, and the design, construction, and evaluation of an experimental accelerator system. More than 100 test projectiles were fired with a 10 ft, two turn experimental accelerator energized by a 12,500 j capacitor bank-transformer arrangement. A maximum muzzle velocity of 1990 ft/sec was attained with a 5.8 g steel-aluminum projectile at a conversion efficiency of 8.5%. The best results were obtained with projectiles having a hard metallic sleeve which partially confined the molten metal at the contact surfaces. From this work it was concluded that the most serious problem in achieving hypervelocities with the parallel rail electromagnetic accelerator is the contact problem. The use of multiple turns and a projectile design which minimizes the arcing losses appear to be the most promising approaches. Inductive and capacitive storage were concluded to be the most suitable energy sources for a parallel rail hypervelocity accelerator installation. (Contractor's abstract)

IIT.10:001 - IIT.10:005

IIT.10:001

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

RADIATION SYNTHESIS OF FLUORINATED AROMATIC COMPOUNDS, by P. Y. Feng and L. Mamula. [1957] 5p. incl. diagrs. (AFOSR-TN-57-537) (AF 18-(603)121) AD 136523 Unclassified

A series of radiation induced cross-halogenations were observed which are exemplified by these overall reactions: (1) $C_6H_6 + CF_4 \rightarrow C_6H_5CF_3 + HF$ and (2) $C_6H_6 + CF_4 \rightarrow C_6H_5F + CHF_3$. Other systems studied included C_6H_6 or $C_6H_5CH_3$ irradiated together with γ rays; the liquid portions were then analyzed by means of an IR spectrophotometer. The data indicate the formation of $C_6H_5CF_3$, C_6H_5F , and CHF_3 . The formation of HF was indicated by the attack on the walls of the capsules. Under the conditions of the experiments CF_4 dissolved in benzene according to Henry's law, and the $G(\text{radical})$ values of CF_4 - benzene systems were of the order of 0.7 to 1.1 as determined by the diphenyl picryl hydrazyl method.

IIT.10:002

[Illinois Inst. of Tech.] Armour Research Foundation,
Chicago.

THE USE OF POLYMER DEGRADATION REACTIONS IN RADIATION DOSIMETRY (Abstract), by P. Y. Feng. [1957] [1]p. [AF 18(603)121] Unclassified

Presented at meeting of the Amer. Nuclear Soc.,
New York, Oct. 28-31, 1957.

Published in Second Winter meeting of the Amer.
Nuclear Soc. Program and Abstracts, Oct. 29, 1957,
p. 47.

Conventional dosimetry systems employing aqueous solutions of solid materials can be applied to organic systems only after corrections for absorption differences. Moreover, many of the dosimeter systems are applicable only to limited radiation dosage ranges because of their inherent limitations, such as the ferrous sulfate dosimeter, or their intended range, e.g., the ceric sulfate dosimeter. The radiation induced degradation of polymers in solution may be used as a dosimetry system with a wide dosage range and an easy method of measurement. It is shown that radiation dosages over four orders of magnitude can be measured readily with one dosimetry system. Experimental work was performed with polystyrene in halogen containing solvents. The effects of concentration, molecular weight and dosage were studied. The results and a detailed analysis of them are reported.

IIT.10:003

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

PREPARATION OF FLUORO-CHEMICALS BY RADIATION INDUCED CROSS-FLUORINATION. Technical rept. Sept. 16, 1956-Sept. 15, 1957. Dec. 2, 1957, 42p. incl. diagrs. tables, refs. (AFOSR-TN-58-20) [AF 16-(603)121] AD 148089; AD 150616 Unclassified

The radiation behavior of a number of fluorine compounds, including CF_4 , CHF_3 , CF_2Cl_2 , $CFCF_3$, $C_2F_4Cl_2$, C_6H_5F and $C_6H_5CF_3$ in the presence of benzene and other organic compounds was studied. Diphenyl picryl hydrazyl disappearance and polymer degradation experiments showed that the fluorine compounds studied have considerably lower radiation sensitivities than the corresponding chlorine or bromine compounds. Irradiation of solutions of the fluorocarbons in benzene produced aromatic fluorine compounds with a total G value up to approximately 3 in the more favorable cases in spite of the known stability of fluorocarbons toward attack by radicals. On the basis of the radical yield data, it was concluded that free radical reactions cannot be responsible for the formation of all of the fluorinated aromatic compounds. Ion-molecule reactions in the liquid state are suggested as a possible contributing factor to the observed reaction results. (Contractor's abstract)

IIT.10:004

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

RADIOLYSIS OF CF_4 - C_6H_6 SYSTEMS, by P. Y. Feng and L. Mamula. [1956] [2]p. incl. diagrs. (AF 18(603)-121) Unclassified

Published in Jour. Chem. Phys., v. 28: 507-508, Mar. 1958.

Infrared spectra of the radiation induced cross-halogenation in carbon tetrafluoride - benzene systems indicates the presence of $C_6H_5CF_3$, C_6H_5F , and CHF_3 , as well as HF. It is concluded that a free radical induced reaction is not responsible for these products, but perhaps rather an ionic reaction takes place.

IIT.10:005

[Illinois Inst. of Tech.] Armour Research Foundation,
Chicago.

RADIATION EFFECT IN ORGANIC FLUORINE COMPOUNDS (Abstract), by P. Y. Feng and L. Mamula. [1958] [2]p. incl. tables. [AF 18(603)121] Unclassified

HT. 10:006; HT. 11:001

Presented at Fourth annual meeting of the Amer. Nuclear Soc., Los Angeles, Calif., June 2-5, 1958.

Published in Trans. Amer. Nuclear Soc., v. 1: 39-40, June 1958.

Irradiation of solutions of the simple fluorocarbons, e.g., carbon tetrafluoride in aromatic hydrocarbons, produces metathetical products as exemplified by the reaction $CF_4 + C_6H_6 \rightarrow C_6H_5F + CHF_3$ or

$CF_4 + C_6H_6 \rightarrow C_6H_5CF_3 + HF$. The yields of these metathetical products increase with the CF_4 to C_6H_6

ratio. The highest yield so far corresponds to a $G(C_6H_5CF_3 + C_6H_5F)$ of 3, and was obtained with the CF_4 - C_6H_6 system under approximately four atmospheres CF_4 pressure. Results are given of other systems studied. If the $C_6H_5CF_3$ and C_6H_5F from the irradiation of CF_4 and C_6H_6 was produced by a radical process, only radical combination processes can be responsible for the observed products because CF_4 is inert toward attack by C_6H_5 or H radicals whereas F or CF_3 form either addition or degraded products with C_6H_6 . Using the dpph method, the G (radical) values of a series of fluorine compounds have been determined and are shown in this report. A number of radical combination processes in addition to those leading to $C_6H_5CF_3$ and C_6H_5F formation are possible.

Furthermore, the diphenyl picryl hydrazyl technique gives as a rule the highest radical yields in the literature. On the basis of radical yield data alone, one would expect a maximum $G(C_6H_5F + C_6H_5CF_3)$ value of the order of $\frac{1}{2}PG_r$, where P is the probability of the radical combination reaction leading to the observed product and is of the order of 0.1 (the factor $\frac{1}{2}$ comes from the fact that 2 radicals are needed to form one molecule). Thus the $G(C_6H_5CF_3 + C_6H_5F)$ value

should be of the order of 0.1. The observed rather high value of G must therefore be due to mechanisms other than those of a radical nature, and reaction mechanisms involving ionic species are suggested. Irradiation of solutions of polystyrene in fluorinated liquids results in, among others, degradation of the polymeric material. Comparison of the polymer degradation data in such systems with data from the degradation of polystyrene in CCl_4 , C_6H_6 , etc., shows also that the radiation stability of the fluorine compounds approaches those of the corresponding hydrogen analogs and are much lower than those of the chlorine analogs. In addition, whereas energy transfer occurs readily from C_6H_6 to CCl_4 in CCl_4 - C_6H_6 systems, the transfer of absorbed radiation energy from C_6H_6 to compounds such as C_6H_5F is of only minor importance. Such

differences, as are expected on the basis of energy level consideration, are also confirmed in the experiments.

HT.10:006

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

RADIATION CHEMISTRY OF ORGANIC HALOGEN COMPOUNDS (Abstract), by P. Y. Feng. [1958] [1]p. (AF 18(603)121) Unclassified

Presented at Internat'l. Congress of Radiation Research, Burlington, Vt., Aug. 11-15, 1958.

Published in Radiation Research, v. 9: 113, July 1958.

Radiation chemistry of organic halogen compounds is an interesting subject in view of the high radiation sensitivity of the organic chlorine, bromine, and iodine compounds and the relative radiation stability of organic fluorine compounds. In this paper, recent experimental results supplementing publications elsewhere which report work in progress at the Foundation will be described, including diphenylpicrylhydrazyl disappearance, gas yield, polymer degradation, and product analysis. As a rule, it has been found that the radiation stability of fluorinated organic compounds is far greater than that of the other halogenated compounds and compares with that of the corresponding hydrocarbons. The effect of the halogen groups on the radiation behavior of a molecule is found to be usually additive. For mixtures containing the halogenated organic compounds, energy transfer processes are generally feasible, but there are also processes which cannot be adequately explained by radical mechanisms. Such reactions will be described and the possibility of liquid phase ion-molecule reactions will be discussed.

HT.11:001

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

A STUDY OF A FAMILY OF LAVES-TYPE INTERMEDIATE PHASES, by R. P. Elliott. Final technical rept. Feb. 21, 1958, 15p. incl. diagrs. (AFOSR-TR-58-49) (AF 18(603)130; continuation of AF 18(600)1399) AD 154199 Unclassified

Ternary alloys between binary Laves-type phases of transition elements have been used to investigate the valencies of the transition elements. Systems containing constant atomic proportions of niobium, tantalum, and hafnium indicate, as had previous systems containing titanium and zirconium, that the valencies of the first transition series decrease continuously with increasing atomic number. On the basis of the previously calculated valencies, values between three and four were calculated

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for the valencies of niobium, molybdenum, hafnium, tantalum, and tungsten. Limited data indicate that the valencies of the second and third transition series increase and then decrease with increasing atomic number. Generalizations concerning the variation of valency for a given group could not be made. Unreconcilable data indicate that factors other than the free electronic valency are affecting the free energy and hence the miscibility ranges of the ternary Laves phases. (Contractor's abstract)

IIT.12:001

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

PHOTOELASTIC STUDY OF STRESS WAVE PROPAGATION IN LARGE PLATES, by J. W. Dally, A. J. Durelli, and W. F. Riley. Nov. 5, 1958, 28p. incl. illus. diagrs. table. (AFOSR-TN-58-748) (AF 18(603)144) AD 162271; PB 138061 Unclassified

Dynamic photoelastic methods with a low modulus urethane rubber compound as the model material were employed to study wave propagation in large plates. The loading was accomplished by using small package explosives in the form of electrical primers. The charges were placed at the corner and center of one long side of a large rectangular plate. It was found that the photoelastic fringe patterns could in certain cases be related to the dilatational and distortional waves produced by the explosion. The effect of the reflection of the dilatational wave at glancing incidence was to increase the boundary fringe order at the leading edge of the wave by about 50%. The maximum fringe order which moved along an interior line decayed as it propagated away from the point of load application as a function of $r^{-3/2}$. (Contractor's abstract)

IIT.12:002

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

A PHOTOELASTIC APPROACH TO TRANSIENT STRESS PROBLEMS EMPLOYING LOW MODULUS MATERIALS, by J. W. Dally, W. F. Riley, and A. J. Durelli. Oct. 1958, 36p. incl. illus. diagrs. refs. (AFOSR-TN-58-891) (AF 18(603)144) AD 204138; PB 139408 Unclassified

Also published in Jour. Appl. Mech., v. 26: 613-620, Dec. 1959.

An attempt was made to develop a method for studying dynamic stress distributions by using photoelasticity and low-modulus materials. Hysol 8705, a urethane rubber compound, was selected as the most promising low-modulus material. The mechanical and optical properties of Hysol 8705 were studied under static and

dynamic loadings. The modulus of elasticity and the strain fringe value were dependent on the rate of loading. Poisson's ratio and the stress fringe value were independent of the rate of loading for strain rates greater than 8 in./in./sec. The specific energy loss for the material was about 10% for the stress ranges associated with photoelastic determinations. Experimental observations of photoelastic fringe patterns in a rectangular strut subjected to axial impact were made to illustrate the potential of the method. Three different end conditions were imposed on the unloaded end of the strut; (1) a free end normal to the axis, (2) a fixed end normal to the axis, and (3) a free end inclined 45° to the axis. The fringes, in cases where ends were normal to the axis, followed the same law of reflection as the law for stresses given by elementary wave theory. (ASTIA abstract)

IIT.12:003

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

STRESS CONCENTRATION FACTORS UNDER DYNAMIC LOADING CONDITIONS, by A. J. Durelli, J. W. Dally, and W. F. Riley. Dec. 1958, 23p. incl. illus. diagrs. table. (AFOSR-TN-58-892) (AF 18(603)144) AD 204137; PB 139407 Unclassified

Dynamic photoelastic methods, with a low modulus urethane rubber as the model material, were employed to study stress concentrations resulting from geometric discontinuities in rectangular bars subjected to an axial impact. The impact was applied by dropping a weight on one end of the bar, and the dynamic fringe patterns were photographed with both a Fastax camera and a microflash-still camera combination. The results of the investigation showed that the maximum stress in a rectangular bar with a central circular hole occurs at the same minimum section for static or dynamic loading, and the stress concentration factors are the same. Whether the coincidence of the static and dynamic stress concentration factors is a general law remains to be established. It was also established in the investigation that the average velocity of fringe propagation through the region of the discontinuity is the same as the velocity of fringe propagation in a region of the bar far removed from the discontinuity. Thus, a fringe reaches a point after the discontinuity at the precise time it would have reached the point had the discontinuity not been present. (Contractor's abstract)

IIT.12:004

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

DEVELOPMENTS IN THE APPLICATION OF THE GRID METHOD TO DYNAMIC PROBLEMS by A. J. Durelli, J. W. Dally, and W. F. Riley. Dec. 1958, 26p.

ITT.13:001, 002; ITT.14:001, 002

incl. illus. diagrs. (AFOSR-TN-58-893) (AF 18(603) 144) AD 204136; PB 137783 Unclassified

Also published in Jour. Appl. Mech., v. 26: 629-634, Dec. 1959.

The grid method for use in dynamic stress studies is discussed. A rubber-thread grid network in a low modulus model material (a urethane rubber known as Hysol 8705) was used in conjunction with a microflash light source to record grid distortions and photoelastic fringe patterns in a model subjected to dynamic loading conditions. By considering a strut subjected to axial impact it was possible to establish that the static and dynamic values of Poisson's ratio were identical, and the strain fringe value of the material varied with strain rate. In addition, stresses in the axial and transverse directions were determined along the centerline of the strut. Finally, the methods established were applied to the problem of a circular disk subjected to diametrical impact and both principal stresses were determined along a vertical diameter at one instant during impact.

ITT.13:001

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PROPERTIES OF SULFIDE SEMICONDUCTORS, by J. W. Buttrely. Technical rept. no. 1, Jan. 1-Dec. 31, 1957. July 1, 1958, 7p. incl. diagrs. (AFOSR-TN-58-596) [AF 49(638)112] AD 162120 Unclassified

A study has been carried out on the fabrication methods and electrical characteristics of a group of sulfides, selenides, and tellurides. Unsuccessful attempts have been made to fabricate semiconductors from either MoS_2 or NiS because of cracking or high reactivity.

Samples of Sb_2Se_3 , ZnTe , PbTe , and AgTe samples were prepared by melting the constituents in a fused quartz tube in a hydrogen atmosphere. The Sb_2Se_3 sample showed semiconducting properties with an activation energy of 0.82 ev. Hall measurements on a ZnTe sample indicated a carrier density in excess of $5 \times 10^{20}/\text{cc}$ and thus metallic conductivity.

ITT.13:002

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PROPERTIES OF SULFIDE SEMICONDUCTORS, by J. W. Buttrely. Technical rept. no. 5, Jan. 1-Mar. 31, 1958. July 9, 1958, 6p. incl. diagr. table. (AFOSR-TN-58-644) [AF 49(638)112] AD 162176 Unclassified

A series of samples of As_2Te_3 and Sb_2Se_3 have been prepared in pure and doped form and preliminary meas-

urements begun on these samples. Hall effect measurements have been made and these measurements, together with thermoelectric measurements, show that all the samples, doped and undoped, are p type semiconductors.

Carrier densities of the order of 10^{19} - 10^{20} carriers per cc are measured for all the samples. The sample with the highest carrier density is a "pure" As_2Te_3 sample which was zone refined. (Contractor's abstract)

ITT.14:001

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

THE RESPONSE OF CRYSTAL PHOSPHORS TO NUCLEAR RADIATION, by L. Reiffel. June 4, 1957, 52p. incl. illus. diagrs. tables. (Technical note no. 1) (AFOSR-TN-57-313) (AF 49(638)113) AD 132384 Unclassified

The utility of a parameter other than temperature is being investigated for its effect on luminescence behavior of the simple alkali halide phosphors. The effect of pressure on luminescent systems is examined with particular reference to the phosphorescent decay of long-lived traps in Tl -activated NaI . Important parameters of the trapping centers may be obtained by subjecting the phosphor to hydrostatic stress during phosphorescent decay. Increased pressure tends to favor configurational coordinate distances smaller than equilibrium values, while thermoluminescence experiments and other techniques which rest on variations in temperatures carry the system with equal probability to larger and smaller than equilibrium values of configurational coordinates. The critical displacement of I^- from their equilibrium position which allows thermal collapse of a specific trap in NaI (Tl) is $+0.19\text{\AA}$ (an outward displacement). For another trap in the same material, thermal collapse sets in with the ions moved inward by -0.045\AA . The effect of these displacement values is observed as a change in phosphorescent lifetime under pressure. As a second illustration of the utility of pressure, a type of experiment, termed the pressure break, was devised which is essentially equivalent to experiments where the temperature of the phosphor is changed over large ranges, almost instantaneously. The ability of the phosphor to stand rapid pressure changes permits experiments to be conducted at essentially constant light sum in the crystal. The technique is still in the early stages of development.

ITT.14:002

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PRESSURE EFFECTS IN LUMINESCENCE, by L. Reiffel. May 26, 1958, 17p. incl. illus. diagrs. (AF 49(638)113) Unclassified

ITT. 05:002, 003; ITT. 15:001;
ITT. 16:001

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 137, Mar. 27, 1958.

Also published in Proc. Internat'l. Conf. on Solid State Physics in Electronics and Telecommunications, Brussels (Belgium) (June 2-7, 1958), N. Y., Academic Press, v. 4 (Part 2): 697-704, 1960.

Study is made of the effect of pressure on the isothermal phosphorescent decay of thallium-activated alkali halides. Data is included on so-called pressure break experiments which involve rapid changes in pressure such that the light sum in the crystal remains sensibly constant during the pressure change. This method has great advantage when dealing with very long-lived traps where isobaric runs of extraordinary duration would be required. It is shown that first order kinetics may be used to explain both the changes in brightness occasioned by pressure transients and the changes in lifetime produced by static pressurization. The activation volumes required for the one process also fit the data for the other process in the case of NaI(Tl). (Contractor's abstract, modified)

ITT.05:002

Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

CRYOSCOPIC BEHAVIOR OF H_2O AND HNO_3 IN

FUSED AMMONIUM NITRATE, by A. G. Keenan. Feb. 1957, 8p. incl. diagr. table, refs. (Technical note no. 2 (6101)) (AFOSR-TN-57-32) (Also bound with its Final rept. Sept. 1, 1954-Sept. 1, 1957; AFOSR-TR-57-48; AD 132478) (AF 18(600)1148) AD 115067

Unclassified

Also published in Jour. Phys. Chem., v. 61: 780-782, June 1957.

H_2O and HNO_3 have been studied cryoscopically as solutes in NH_4NO_3 melts. H_2O alone, as well as mixtures of the 2 solutes, show v-factors of unity based on stoichiometric mole fraction concentrations determined by analysis of the melts. A consistent set of molecular species is postulated to account for the observed v-factor and the results related to proposed mechanisms for the thermal decomposition of NH_4NO_3 . (Contractor's abstract)

ITT.05:003

Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

KINETICS AND MECHANISMS IN IONIC MELTS, by A. G. Keenan. Final rept. Sept. 1, 1954-Sept. 1, 1957

[18]p. incl. diagrs. tables, refs. (AFOSR-TR-57-48) (AF 18(600)1148) AD 132478; PB 138490

Unclassified

An ultraviolet spectroscopic investigation was made of thin fused NH_4NO_3 samples. The data show the manner in which the resolution deteriorated in other samples, and the way in which the total absorbance was decreased where the mounting was less successful. The film was shown to be heterogeneous because of bubbles. The addition of HNO_3 to NH_4NO_3 did not improve the spectra.

The data substantiated the conclusion from cryoscopic data that pure fused NH_4NO_3 is a simple ionic system when approaching its melting point.

ITT.15:001

Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

PHOTOCHEMICAL SYNTHESIS OF ENERGY-RICH COMPOUNDS, by H. E. Gunning. Final rept. Feb. 1-Aug. 31, 1957, 8p. incl. tables. (AFOSR-TN-57-588) (AF 49(638)49) AD 132551

Unclassified

The photochemical and thermal decomposition reactions of methyl mercuric chloride are described. The principal products of the thermal decomposition were methane and benzene with smaller quantities of ethylene and butene. These products suggest that reactions of the type below occur:

- (1) $CH_3HgCl \rightarrow CH_3 + HgCl$
- (2) $CH_3 + CH_3HgCl \rightarrow CH_4 + CH_2HgCl$
- (3) $CH_2HgCl \rightarrow CH_2 + HgCl$

In contrast the photochemical decomposition yields hydrogen, methane, ethane, and propane as the principal products suggesting an entirely different mechanism than the above. Preliminary studies of the photolysis of Al_2Cl_6 vapor are also given.

ITT.16:001

Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

FURTHER STUDIES ON THE RELATIVE BASICITIES OF METHYL- AND SILYLAMINES: TRIMETHYL-GALLIUM AS THE REFERENCE ACID, by S. Sujishi and H. M. Manasevit. [1958] 8p. incl. tables, refs. (AFOSR-TN-58-969) (AF 49(638)276) AD 205602

Unclassified

By the action of trimethylgallium on the appropriate amine, silyldimethylamine-trimethylgallium (m.p. 11.7-13.8°; v.p. 38.4 mm at 0°) were prepared. At 25° and at a total pressure of 100 mm, methylsilylamine-trimethylgallium was completely dissociated. No evidence

ITT. 17:001; ITT. 18:001;
ITT. 06:003, 004

for the combination of trimethylgallium with trisilylamine was obtained at -95° to 25° . Based on the gas phase dissociation data of the addition compounds, the relative basicities toward trimethylgallium as the reference is $(\text{CH}_3)_3\text{N} > (\text{CH}_3)(\text{SiH}_3)_2\text{N} > (\text{SiH}_3)_3\text{N}$.

(Contractor's abstract)

ITT. 17:001

[Illinois Inst. of Tech. Dept. of Mathematics, Chicago.]

ON THE EXISTENCE AND PROPERTIES OF THE LANE INTEGRAL, by R. C. Bzoch. [1957] 35p. (AFOSR-TN-57-233) (AF 18(600)1393) AD 126530 Unclassified

R. E. Lane's generalization of H. L. Smith's definition of an integral known as the Stieltjes mean σ integral is developed in the investigation of Stieltjes integral representations of certain classes of analytic functions. The main result is the development of a necessary and sufficient condition for the existence of the Lane integral. Also presented are some properties of the integral. Certain definitions and results concerning the Stieltjes mean integral and the Lane integral are given. The main existence theorem is in Chapter III and some properties of the Lane integral are in Chapter IV.

ITT. 18:001

Illinois Inst. of Tech. Dept. of Metallurgical Engineering, Chicago.

OBSERVATIONS ON THE MECHANICAL BEHAVIOUR OF HEAT-TREATED STEEL AT HIGH HARDNESS LEVELS, by N. H. Polakowski. [1957] [8]p. incl. diagrs. refs. [AF 18(603)68] Unclassified

Published in Jour. Iron and Steel Inst., v. 185: 67-74, Jan. 1957.

Untempered martensite behaves in many respects like an annealed metal. It has a low elastic limit which can be raised by cyclic stressing; its Meyer index and strain-hardening exponent are high. Despite the high indentation hardness and the internal stresses it contains, fresh martensite work-hardens during plastic deformation although work-softening could have been expected to occur in these conditions. Tempering up to about 300°C causes the strain-hardening properties to decrease progressively and the elastic limit to rise. The impact fracture energy and ductility at sub-zero temperatures fall to a minimum but they can be improved or otherwise altered by prior cold-working at room temperature. Most of these facts cannot be explained or accounted for if the commonly held view of virgin martensite being inherently very hard is accepted as an axiom. However, they all find their natural place in an integrated picture if as-quenched steel is visualized as being relatively soft but capable

of rapid work-hardening when deformed. Tempering below 300°C is assumed to produce a hardening effect roughly similar to that of cold-working. A working hypothesis is developed in the paper based on the above premise and incorporating a Cottrell type mechanism involving locking of dislocations by migration of solute carbon atoms. This is then applied to account for various peculiar aspects of the mechanical behaviour of hardened and tempered steel. (Contractor's abstract)

ITT. 06:003

Illinois Inst. of Tech. Lab. of Physical Electronics, Chicago.

LATTICE DEFECTS IN GERMANIUM AND SILICON AND THEIR EFFECT ON ELECTRICAL PROPERTIES, by P. L. Copeland, J. R. Madigan, and L. J. Fiegel. [Technical rept. no. 2, July 1, 1955- Oct. 1, 1956] Feb. 15, 1957. (AFOSR-TN-57-78) (AF 18(600)643) AD 120422 Unclassified

The equilibrium barrier height of a p-n junction rectifier was measured as a function of temperature from 77° to 373°K . The barrier height was determined by observing the saturation of the open circuit junction decays voltage with increasing forward bias. The height of the barrier at a given temperature is equal to the original difference in Fermi levels in the isolated n- and p-regions of the diode. At low temperatures it should, therefore, approach the energy gap and should tend to zero at high temperatures as both regions approach intrinsic material. Measurements on silicon alloy junction diodes are in general agreement with this predicted behavior and because of the heavy doping of the emitter essentially describe the behavior of the Fermi level in the base region.

ITT. 06:004

Illinois Inst. of Tech. [Lab. of Physical Electronics] Chicago.

FUNDAMENTAL PROCESSES OF FRICTIONAL WEAR IN ALKALI HALIDE CRYSTALS, by P. L. Copeland and E. Zwicker. Oct. 1957, 78p. incl. illu. diagrs. refs. (AFOSR-TR-57-85) (AF 18(600)643) AD 136675 Unclassified

Friction and wear between single crystals of lithium fluoride was extensively investigated. The mechanism proposed by Bowden and Tabor to explain the features of metallic friction was found to apply also to friction in lithium fluoride. This mechanism was particularly successful when applied to explain the characteristics of the special fractures of triangular shape named "deitas" which were formed in (100) surfaces. The presence or absence of a dislocation layer in the surface of lithium fluoride was found to affect the character of the deitas. The roughness of the surfaces also had an effect on the

IIT. 06:005; IIT. 07:002;
ISG. 01:002

deltas. The alkali halides LiF, NaCl, KCl and KBr were compared in friction and wear, and a significant trend was found in the wear features which appeared to show dependence on cohesive energies and ion sizes of the crystals. Electropolished copper single crystals in friction with silicon and brass displayed a peculiar dependence of coefficient of friction on load. No wear was detected in the case of copper on silicon. Electropolished single crystals of copper and nickel on polycrystalline zinc behaved as might be expected, showing a small but steady decrease in coefficient of friction with load which is often observed in a wearing in process. (Contractor's abstract)

IIT.06:005

Illinois Inst. of Tech. [Lab. of Physical Electronics]
Chicago.

FRICITION AND WEAR IN LITHIUM FLUORIDE
(Abstract), by E. Zwicker and P. L. Copeland. [1958]
[1]p. [AF 18(600)643] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago
U., Ill., Nov. 28-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
359, Nov. 28, 1958.

The nature of friction and wear between single crystals of lithium fluoride was extensively investigated. The general mechanism proposed by Bowden and Tabor to explain metallic friction is equally applicable to lithium fluoride, and explains the unique triangular shaped "deltas" formed in the (100) surfaces by controlled sliding friction between single crystals. The previous treatment of the crystals, particularly the presence or absence of a layer of dislocations in the surface, affects the shape and depth of the deltas. Using the techniques of Gilman and Johnston to develop etch pits, it was possible to observe the array of dislocations produced by friction, especially in the region of a delta.

IIT.07:002

Illinois Inst. of Tech. Physiological Psychology Lab.,
Chicago.

POLYMERIZATION OF VITREOUS HUMOR SUBSTRATE IN LIGHT AND DARK ADAPTATION, by P. S. Shurrager. Final rept. Dec. 1958, 1v, incl. illus. diagrs. tables, appendices (AFOSR-TR-58-161) (AF 18(600)576)
AD 207460; PB 142101 Unclassified

Changes in chemical and physical properties of vitreous during adaptation: Turbidimetric analysis, acid hydrolysis, photolysis color development with ninhydrin, vitreous humor changes in dark adaptation following light adaptation, effect of flash of light upon vitreous humor hydrolysis, change in vitreous humor hydrolysis

during 1 min of dark adaptation after 30 sec of light adaptation, changes in protein fragmentation rates of frozen and fresh dark adapted vitreous humor, relationships among several vitreous humor biochemical systems during the 1 to 60 min dark adaptation period, general observable relationships among the rates of biochemical processes, and relative rates of biochemical changes in vitreous humor as functions of light adaptation time. Physical properties of vitreous: Viscosity changes of vitreous humor in dark adaptation, electron-microscopy, and fluorescence differences in dark and light adapted vitreous humor. Chemical characterization of vitreous humor components: Temperature effects in the rate of acid hydrolysis of light and dark adapted vitreous substrate: Photochemical studies on vitreous and model vitreous systems: Bioelectric studies: Bioelectric activity of mammalian eyes, and exploratory analysis of electroencephalography (EEG) components. Psychophysical measurements of human threshold sensitivity: Appendix I: Calibration of a photomultiplier scale in energy equivalents (microwatts and quanta per second). Appendix II: Psychophysical studies of the visibility threshold.

ISG.01:002

Illinois State Geological Survey. [Div. of Fluorine
Chemistry] Urbana.

AROMATIC FLUORINE COMPOUNDS BY KF FLUORINATION (Abstract), by G. C. Finger, C. W. Kruse and others. [1957] [1]p. [AF 18(600)985]

Unclassified

Presented at meeting of the Sixteenth Internat'l.
Congress of Pure and Appl. Chem., Paris (France),
July 18-24, 1957.

Published in Résumés des Communications, v. 2: 303,
July 1957.

Replacement of aromatic -Cl and -NO₂ groups by -F in activated aryl halides with KF was reported by Finger and Kruse. The present paper discusses recent research and conclusions. Examples of nitroaryl halides studied in dimethylformamide (DMF) and dimethyl sulfoxide (DMSO) are: 3-fluoro-4-chloro-, 2,3- and 2,5-dichloro-, 3-fluoro-2,4-dichloro-nitrobenzenes. All showed -Cl replacement in the 2 and 4 positions. The isolation of a small amount of 2,3-dichlorofluorobenzene in the second example indicated -NO₂ replacement by -F. 2,5-Dichloronitrobenzene gave both 2,5-dichlorofluorobenzene and 5-chloro-1,2-difluorobenzene as by-products. 1,3-Difluoro-4,6-dinitrobenzene was obtained quantitatively by heating at steam bath temperature the chloro analog with KF in DMF. Activation by the -CN group in 2-chlorobenzonitrile is very slight; a trace of 2-fluorobenzonitrile was formed and identified as 2-fluorobenzoic acid. The reactivity of polychlorobenzenes to KF was examined. Preliminary results indicate that

ILL.02:004 - ILL.02:007

the 1,2,3,5-tetrachloro-, pentachloro-, and hexachlorobenzenes show considerable lability of certain chlorine atoms. Hexachlorobenzene gave 2,4,6-trichloro-1,3,5-trifluorobenzene. As in the case of 1,2,3-trifluorobenzene, the KF method made possible the synthesis of 1,2,3,4-tetrafluorobenzene, b. p. 93.5-94°, n_D^{20} 1.4069.

ILL.02:004

Illinois U. Dept. of Ceramic Engineering, Urbana.

THERMAL FRACTURE RESISTANCE OF CERAMIC COATINGS APPLIED TO METAL. I. ELASTIC DEFORMATION, by J. H. Lauchner and D. G. Bennett. May 1957, 18p. incl. diagrs. tables, refs. (Rept. no. 78) (AFOSR-TN-57-52) (AF 18(603)28) AD 115091
Unclassified

Presented at Fifty-ninth annual meeting of the Amer. Ceram. Soc., Dallas, Tex., May 6, 1957.

Also published in Jour. Amer. Ceram. Soc., v. 42: 146-150, Mar. 1, 1959.

The resistance to thermal fracture exhibited by ceramic coatings applied to iron was studied in the unsteady state. Physical properties and residual stresses in the coated systems were related to thermal shock resistance. Coating failure was observed to occur when a critical shock temperature differential was exceeded and the stresses necessary to induce fracture were identified by the thermal and residual stresses developed. Theoretical analysis based on flat plate specimens and experimental results were in close agreement. (Contractor's abstract)

ILL.02:005

Illinois U. Dept. of Ceramic Engineering, Urbana.

THE EFFECT OF PRE-STRESSING ON THE STRENGTH OF CERAMIC COATINGS, by J. H. Lauchner, D. G. Bennett and others. Sept. 1957, 30p. incl. diagrs. tables, refs. (Rept. no. 79) (AFOSR-TN-57-768) (AF 18(603)28) AD 136758
Unclassified

Abstract published in Jour. Amer. Ceram. Soc., v. 42: 4h, Jan. 1, 1959.

The brittle quality of ceramic coatings has been recognized for years, but only limited quantitative information is available on the maximum strain which coatings will withstand without fracture. This study was undertaken to evaluate the effect of residual coating strain on the fracture resistance of a coating under statically induced strains. Ceramic coatings were applied to sheet iron strips and the residual strains developed as a result of thermal treatment were calculated. The coated-metal strips were statically loaded to induce axial tension,

buckling or torsion. Coating strain was measured by means of SR-4 strain gages or calculated from optical measurements of the maximum deflection in buckling. Coating fracture was indicated by an electrified particle technique and the coating strength resolved into terms of residual and mechanically induced strains. Coatings were observed to fracture when strained approximately $1,000 \times 10^{-6}$ in./in. in tension. Compression failure occurred when strains of $10,000^{-6}$ in./in. were exceeded. The maximum strain which could be induced into the coating without fracture appeared to be the algebraic sum of residual strain and the critical strain at which fracture occurred. (Contractor's abstract)

ILL.02:006

Illinois U. Dept. of Ceramic Engineering, Urbana.

THE EFFECT OF SINGLE OXIDE ADDITIONS ON THE DEVITRIFICATION TENDENCIES OF A BARIUM-BORO-SILICATE CERAMIC COATING GLASS, by R. R. Reschetz, W. R. Bratschun and others. Sept. 1957, 27p. incl. illus. tables. (Rept. no. 80) (AFOSR-TN-58-251) (AF 18(603)28) AD 154154; PB 133961
Unclassified

The effect of single oxide additions of ceria, titania, ceria, bismuth oxide and zinc oxide on the devitrification tendencies of a barium-boro-silicate glass was investigated. Coated specimens on type 347 stainless steel were examined by x-ray diffraction after exposures at 871°C for times up to 150 hr. All of the additions studied delayed to some extent the initial appearance of the devitrification products as compared to the base glass. All coatings of the ceria and zinc oxide series plus those compositions with smaller molar additions of TiO_2 and Bi_2O_3 appeared to retain their continuity and dimensional stability after 150 hr of heating at 871°C. Of these, the coating with 1.50 mol of ceria appeared to be the best. This coating, as well as the coating with 2.00 mol of ZnO , exhibited the least crystalline change over the 150 hr of heat treatment at 871°C. Powder patterns on selected coating samples revealed the existence of preferred orientation and selective crystallization at or near the coating surfaces. Although certain coatings exhibited considerable crystalline activity, they still retained continuity and stability characteristics.

ILL.02:007

Illinois U. Dept. of Ceramic Engineering, Urbana.

SOME STUDIES OF THE INTERACTION OF COBALT AND NICKEL WITH TITANIUM DIBORIDE, by T. A. Willmore and D. G. Bennett. Apr. 1958, 44p. incl. illus. tables. (Rept. no. 81) (AFOSR-TN-58-515) (AF 18(603)28) AD 158326
Unclassified

ILL.02:008 - ILL.02:010

When combinations of cobalt and titanium diboride are heated in the temperature range of 1600° to 2750°F, chemical reaction occurs to produce titanium monoboride and cobalt boride. The observed tendency for cobalt and titanium diboride to persist is interpreted as a function of the ratios of these reacting constituents. Melting was detectable at temperatures as low as 2000°F and, for compacts containing 95 wt-% cobalt - 5 wt-% titanium diboride, melting was essentially complete at approximately 200°F below the melting point of cobalt. Due to the number of phases formed the mechanism of melting is probably not a simple process. It was established that boron is essential to produce low melting effects by substituting titanium for titanium diboride on a titanium-equivalent basis. Compacts of nickel and titanium diboride yielded results which closely paralleled those obtained with cobalt and titanium diboride. Their melting characteristics, however, indicated that the slope of the liquidus is probably less steep than in the cobalt system. In both systems, a prevalent tendency for melt and solid fractions to separate makes it difficult to maintain homogeneous samples. Hence, equilibrium is difficult to establish.

ILL.02:008

Illinois U. Dept. of Ceramic Engineering, Urbana.

STUDIES OF THE STABILITY OF HIGH TEMPERATURE RESISTANT CERAMIC COATING GLASSES, by W. R. Bratschun, C. N. Williams, and D. G. Bennett. July 1958, 33p. incl. illus. diagrs. tables. (Rept. no. 82) (AFOSR-TN-58-828) (AF 18(603)28) AD 202913 Unclassified

X-ray diffraction analysis of a series of glass-metal composite specimens heat treated up to 200 hr at 870°C revealed 2 types of glass devitrification behavior: (1) the cyclic development, disappearance, and reappearance of various diffraction peaks, indicating considerable crystalline activity, and (2) for certain glasses the early development of diffraction peaks which persisted throughout the 200-hr heat treatment. An equilibrium between the devitrification products and the residual glass was indicated in the second type of behavior. A complex coating glass composed of a simple barium borosilicate with additions of 5 oxides, CaO, ZnO, TiO₂, Bi₂O₃ and CeO₂, was found to devitrify slower but to form the same crystalline products as the simple glass. Single additions of these oxides to the simple glass delayed the initial appearance of devitrification products. CaO, ZnO, Bi₂O₃, and TiO₂ additions went into solution during smelting and later apparently took part in the devitrification process by forming compounds with BaO, B₂O₃, and/or SiO₂. CeO₂ additions went into solution during smelting, but crystalline ceria precipitated during firing and remained as a separate phase during subsequent heat treatment.

ILL.02:009

Illinois U. Dept. of Ceramic Engineering, Urbana.

FATIGUE AND INTERNAL STRESS ANALYSIS OF CERAMIC COATED METAL COMPOSITES, by J. H. Lauchner and D. G. Bennett. Sept. 1958, 32p. incl. diagrs. tables, refs. (Rept. no. 83) (AFOSR-TR-58-129) (AF 18(603)28) AD 203494 Unclassified

Ceramic coated metal composites were studied in regard to their behavior under mechanically and thermally induced stresses. Residual coated metal system stresses were measured as a function of temperature and integrated with analysis of thermal shock, static and repeated loadings. Coating metal interfacial structure considerations indicate a saturation of the glassy phase by oxides of the base metal accompanied by the presence of residual strain gradients essentially within the interfacial zone. Theoretical analysis of flat plate coated metal composites was found to be in close agreement with experimental results obtained from annealed coated metal specimens in the absence of viscous or plastic flow. Cobalt bearing vitreous ceramic coatings were observed to fracture when strained approximately 1,000 micro in./in. in tension or 10,000 micro in./in. in compression under room conditions and finite straining periods. The maximum induced strain (thermal or mechanical) which cobalt bearing ceramic coatings could withstand without fracture was found to be a function of residual stress.

ILL.02:010

Illinois U. Dept. of Ceramic Engineering, Urbana.

SOME STRUCTURE AND PROPERTY STUDIES OF RADIATION REFLECTIVE CERAMIC COATINGS, by Z. Johnson, H. G. Lefort, and D. G. Bennett. Sept. 1958, 45p. incl. illus. diagrs. tables. (Rept. no. 84) (AFOSR-TR-58-138) (AF 18(603)28) AD 204555 Unclassified

The objective of the work described was to study and record the chemical behavior of various radiation reflective crystallites in different types of matrix glass, all under controlled heat treatments. It was necessary to confine the scope of the investigation to a study of the behavior of crystalline CeO₂ in two types of matrix glass, one alkali and alumina rich and the other alkali and alumina free, plus a limited study of the chemical behavior of stabilized zirconia in matrix glasses of simple barium-boro-silicate type. The results obtained with zirconia are reported in the Appendix. After laboratory techniques had been suitably resolved, significant measurements were made by x-ray and radiant energy emissivity methods. It was found that the alkali and alumina bearing matrix glass showed a greater devitrification tendency than the alumina and

ILL.02:011; ILL.03:002-004

alkali free glass; increasing amounts of CeO_2 correspondingly tend to reduce the devitrification tendencies in the alumina and alkali bearing glass; cerium oxide is more stable in an environment free of alkali and alumina than in one containing them; increasing amounts of CeO_2 correspondingly tend to increase the suppression, or reflectance of radiant energy; and with increased heating time (at 76°C) the coatings consisting of CeO_2 in an alkali and alumina rich matrix glass lose their radiation suppressive properties much more rapidly than do the coatings consisting of CeO_2 in an alumina and alkali free matrix glass.

ILL.02:011

Illinois U. [Dept. of Ceramic Engineering] Urbana.

THE EFFECT OF RESIDUAL STRESS ON THE FATIGUE STRENGTH OF CERAMIC COATING-METAL COMPOSITES (Abstract), by J. H. Lauchner and D. G. Bennett. [1958] [1]p. [AF 18(603)28] Unclassified

Presented at Sixtieth annual meeting of the Amer. Ceram. Soc., Pittsburgh, Pa., Apr. 29, 1958.

Published in Bull. Amer. Ceram. Soc., v. 37: Program, p. 39, Apr. 29, 1958.

Flat plate fatigue studies of ceramic coating-metal composites were carried out in conjunction with elastic studies of the composites. Calculated residual system stresses were correlated with experimental fatigue data and theoretical analysis of internal strains produced by repeated loading. A relation between fatigue strength and residual stresses was observed for repeated loading below the elastic limit of the coatings.

ILL.03:002

Illinois U. [Dept. of Chemistry] Urbana.

OBSERVATIONS ON THE RARE EARTHS: CHEMICAL AND ELECTROCHEMICAL STUDIES OF SOLUTIONS OF RARE EARTH METAL SALTS IN ANHYDROUS DIMETHYLFORMAMIDE, by T. Moeller and V. D. Galasyn. Apr. 1, 1958, 96p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-158) (AF 18(600)1535) AD 152184 Unclassified

The preparation and purification of solvated rare earth iodides having the general formula: $\text{LnI}_3 \cdot 8\text{DMF}$ ($\text{Ln} = \text{La}$, Pr, Nd, Sm and Gd whereas DMF = dimethyl formamide) is described. The iodides are prepared by reaction between rare earth acetates and acetyl iodide in dimethylformamide. The neodymium compound was also prepared by the metathetical reaction between hydrated neodymium chloride and potassium iodide in dimethyl-

formamide. Preliminary studies of the absorption spectra, x-ray spectra, solubility and conductivity properties, and electro-reduction properties are also discussed.

ILL.03:003

Illinois U. [Dept. of Chemistry] Urbana.

OBSERVATIONS OF THE RARE EARTHS: CHEMICAL AND ELECTROCHEMICAL STUDIES IN NON-AQUEOUS SOLVENTS, by T. Moeller and D. S. Smith. July 2, 1958, 112p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-559) (AF 18(600)1535) AD 158377; PB 136180 Unclassified

Preparation is reported of $\text{NdCl}_3 \cdot 4\text{CH}_3\text{OH}$,

$\text{NdCl}_3 \cdot 3\text{C}_2\text{H}_5\text{OH}$, $\text{NdCl}_3 \cdot 3\text{n-C}_3\text{H}_7\text{OH}$, and $\text{NdCl}_3 \cdot 3\text{n-C}_4\text{H}_9\text{OH}$. The absorption spectrum of NdCl_3

in methanol, ethanol, n-propanol, and n-butanol alcohols was varied. Conductivity studies on NdCl_3 in these alcohols indicated that this salt is a weak electrolyte in methanol and ethanol and becomes progressively weaker in n-propanol and n-butanol. Attempts to electrodeposit Nd metal from these solutions were unsuccessful. Dimethylformamide (DMF) was unsatisfactory as a solvent from which to deposit rare earth metals. However, electrolyses of Sm (III), Eu (III), Gd, and Th chlorides gave nothing but intense red-brown solvent reduction products. $\text{ThCl}_4 \cdot 4\text{DMF}$, $\text{NdBr}_3 \cdot 8\text{DMF}$ and $\text{SrCl}_2 \cdot 3\text{DMF}$ were prepared. Conductance and electrolysis studies on SrCl_2 in DMF indicated that this salt is a weak electrolyte. Electrolyses using various metal electrodes resulted in deposition of an amorphous Sr-containing material; electrolysis using a Hg cathode gave Sr amalgam. Eu (II) chloride is only slightly soluble in DMF; almost insoluble in tetrahydrofuran, ethanol, and acetonitrile; and soluble in ethanolamine. Spectra of Sm (III) and Eu (II) chlorides in DMF and of Eu (II) chloride in acetonitrile were recorded.

ILL.03:004

Illinois U. Dept. of Chemistry, Urbana.

OBSERVATIONS ON THE RARE EARTHS: ELECTROCHEMICAL STUDIES INVOLVING ANHYDROUS PYRIDINE AND ACETONITRILE SOLUTIONS, by T. Moeller and G. Giffin. Aug. 1, 1958, 100p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-589) (AF 18(600)1535) AD 162113 Unclassified

The reaction La_2O_3 with HBr at elevated temperatures to produce anhydrous LaBr_3 was investigated as a

ILL.16:001 - ILL.16:003

method of preparing other rare-earth bromides. Br gas introduced into the reaction with the HBr flow was essential for complete reaction. The preparation of bromides by the reaction of HBr with anhydrous rare earth benzoates was also investigated. X-ray diffraction patterns of the bromides were of 3 types: La and Pr bromides were isomorphous, as were Nd and Sm bromides; GdBr₃ exhibited a third, unidentified structure type. The bromides are moderately soluble in pyridine and slightly soluble in acetonitrile. Crystalline solvated rare earth bromide phases were formed in both solvents during solubility studies. The acetonitrile addition compounds corresponded to the formula LnBr₃·xCH₃CN where x is 3 for La, Nd and Gd; 4 for Sm; and 5 for Pr. The rare earth bromides were found to be weak electrolytes in both acetonitrile and pyridine. The absorption spectra of Nd and Pr bromides in acetonitrile and pyridine, as compared with those in aqueous solutions, showed slight shifts in wavelengths of absorption bands, changes in intensities, and, in the case of Nd, resolution of various bands. Electrolyses of rare earth bromides in pyridine and acetonitrile indicated an increase of rare earth metal ion content of the anolyte.

ILL.16:001

Illinois U. Dept. of Chemistry, Urbana.

DIRECT TITRATION OF HYDROCHLORIC-SULFURIC AND NITRIC-SULFURIC ACID MIXTURES IN ACETONE SOLVENT. AUTOMATIC DERIVATIVE POTENTIOMETRIC OR SPECTROPHOTOMETRIC END POINT DETECTION, by H. V. Malmstadt and D. A. Vassallo. [1959] [5]p. incl. diagrs. tables, refs. (AFOSR-TN-58-75) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)137 and Standard Oil of Indiana) AD 148123 Unclassified

Also published in Anal. Chem., v. 31: 206-210, Feb. 1959.

Accurate automatic methods are described for direct titration of nitric-sulfuric and hydrochloric-sulfuric acid mixtures. Using tri-n-butylmethylammonium hydroxide as titrant and acetone as solvent the proton from either hydrochloric acid or nitric acid is titrated together with the first proton from sulfuric acid to give one end point. The second proton from sulfuric acid is titrated to another end point. Both endpoints are sharp and can be determined successively with equal precision by either automatic derivative potentiometric, automatic derivative spectrophotometric, or manual visual detection. The end point reproducibilities are about 0.01 ml and a relative precision of 0.2% is realized, if a total volume of about 5 ml is involved in each calculation. Solvent and titrant considerations and characteristics of the end point detection systems are discussed. (Contractor's abstract)

ILL.16:002

Illinois U. Dept. of Chemistry, Urbana.

AUTOMATIC DERIVATIVE POTENTIOMETRIC AND SPECTROPHOTOMETRIC TITRATIONS OF ORGANIC ACIDS, by H. V. Malmstadt and D. A. Vassallo. [1959] [4]p. incl. diagrs. tables, refs. (AFOSR-TN-58-200) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)137 and Standard Oil of Indiana) AD 154208 Unclassified

Also published in Anal. Chem., v. 31: 862-865, May 1959.

Nonaqueous titrations of carboxylic acids, sulfonamides, imides, mercaptans, phenols, and enols can be performed rapidly and accurately with a single titrant-solvent combination and automatic derivative potentiometric or spectrophotometric end point termination. The acids are titrated in acetone solvent with tri-n-butylmethylammonium hydroxide titrant. The applicability of many electrode pairs and indicators to potentiometric and spectrophotometric procedures, respectively, was investigated, and the most suitable ones applied to the automatic titration of a variety of acids. The end point reproducibilities are within 0.01 ml of titrant, the buret reading error, and the results show that the automatic derivative procedure is an accurate method for determining percentage purity or neutralization equivalents of organic acids. (Contractor's abstract)

ILL.16:003

Illinois U. Dept. of Chemistry, Urbana.

DETERMINATION OF COPPER AND ZINC IN METALLURGICAL PRODUCTS BY AUTOMATIC DERIVATIVE SPECTROPHOTOMETRIC TITRATIONS, by H. V. Malmstadt and T. F. Hadjiioannou. [1958] [6]p. incl. diagrs. tables. (AFOSR-TN-58-975) (AF 18(603)137) AD 262257 Unclassified

Also published in Anal. Chim. Acta, v. 21: 41-46, July 1959.

Direct automatic derivative spectrophotometric titration procedures for copper and zinc in brasses and bronzes are described. Copper reacts with excess iodide and the liberated iodine is automatically titrated with thiosulfate using the UV absorption band of iodine for end-point detection. Total copper and zinc is automatically titrated with EDTA using PAN as indicator, and zinc is found by difference. The automatic termination of the titrations eliminates the subjective evaluation of the end-points, and the entire procedure is simple, precise and accurate. The total time required for determining copper and zinc in brass or bronze is about twenty minutes. (Contractor's abstract)

ILL. 18:004; ILL. 17:001-003

ILL. 16:004

Illinois U. Dept. of Chemistry, Urbana.

RAPID AND ACCURATE AUTOMATIC TITRATION METHOD FOR DETERMINATION OF CALCIUM AND MAGNESIUM IN PLANT MATERIAL WITH EDTA TITRANT, by H. V. Malmstadt and T. P. Hadjiioannou. [1958] [3]p. incl. tables, refs. (AFOSR-TN-58-977) (AF 18(603)137) AD 262358 Unclassified

Published in *Agricultural and Food Chem.*, v. 7: 418-420, June 1959.

A method is described for the determination of calcium and magnesium in plant materials which combines rapid precipitation and extraction techniques to eliminate interferences and automatic titrations to eliminate subjective evaluation of the end points. The method is more rapid than conventional methods and as accurate. After wet digestion of the plant samples, the total time for determination of both calcium and magnesium is about 15 min, including separations and titrations. (Contractor's abstract)

ILL. 17:001

Illinois U. Dept. of Clinical Science, Chicago.

THE ABSORPTION OF DIETARY CHOLESTEROL IN MAN (Abstract), by T.-M. Lin, E. Karvinen, and A. C. Ivy. [1956] [1]p. [AF 18(606)1580] Unclassified

Presented at meeting of the Amer. Physiol. Soc., Atlantic City, N. J., Apr. 18-20, 1956.

Published in *Fed. Proc.*, v. 15: 120, Mar. 1956.

A study has been made of the extent of the fecal elimination of sterols by nine young healthy subjects when fed a basal relatively low fat and low cholesterol diet to which increasing amounts of cholesterol were added weekly following a control period. The basal diet for the period of one week provided approximately 20 g of fat, 120 g of protein and 490 g of carbohydrates daily. It was adequate in regard to vitamins, bulk, and minerals. The daily menu yielded approximately 2600 cal on the average. Feces were collected from the fourth to seventh day of each dietary period. The serum cholesterol was determined on the seventh day. The mean daily sterol elimination on the low fat and low cholesterol basal diet was 908 mg. The maximum individual cholesterol absorption amounted to 2.8 g. The blood cholesterol was slightly increased when more cholesterol was added in the diet, but the increase was not statistically significant (basal, 185 ± 60 mg% and the highest cholesterol diet, 222 ± 74 mg% of cholesterol).

ILL. 17:002

Illinois U. Dept. of Clinical Science, Chicago.

CAPACITY OF HUMAN INTESTINE TO ABSORB EXOGENOUS CHOLESTEROL, by E. Karvinen, T.-M. Lin, and A. C. Ivy. [1957] [14]p. incl. tables, refs. (AFOSR-TN-57-213) (AF 18(600)1580) AD 126511 Unclassified

Also published in *Jour. Appl. Physiol.*, v. 11: 143-147, Sept. 1957.

The capacity of the human intestine to absorb cholesterol when added in increasing amounts to a basal diet containing approximately 10 g of animal and 10 g of vegetable fat, 380 mg of cholesterol, and 300 mg of phytosterols per day was studied in 16 healthy subjects. Cholesterol was added to this diet for a period of one week in the amounts of 1, 3, 6 and 9 g/day mixed with 17 g of margarine made from hydrogenated soya and cottonseed oil. The average intestinal capacity of the subjects to absorb cholesterol was 2.0 g/day. A maximum capacity of 2.9 g was observed in two different subjects during 19 tests on 16 subjects at the 6 g level of intake. The maximum observed on the 9 g level in 8 subjects was 2.5 g/day. An increase in the margarine intake from approximately 17 g to 40 g/day (total fat from 33 to 50 g/day) did not increase the amounts of cholesterol absorbed. Under the conditions of this study the average maximal intestinal capacity to absorb cholesterol is of the same order of magnitude as the estimated hepatic synthesis of cholesterol. (Contractor's abstract)

ILL. 17:003

Illinois U. Dept. of Clinical Science, Chicago.

SOME PARAMETERS OF STEROL METABOLISM IN MAN ON A STEROL- AND FAT-FREE DIET, by A. C. Ivy, E. Karvinen and others. [1957] [10]p. incl. tables, refs. (AFOSR-TN-57-214) (AF 18(600)1580) AD 126512 Unclassified

Also published in *Jour. Appl. Physiol.*, v. 11: 1-7, July 1957.

The average daily fecal elimination of digitonin precipitable sterol in 11 subjects on a fat- and sterol-free synthetic diet was $421 \text{ mg} \pm 222 \text{ mg/day}$ (standard deviation) with 95% confidence limits of 273 mg and 570 mg/day. When expressed in relation to body weight the mean was 5.8 mg/kg/day with 95% confidence limits of 4.4 and 7.2 mg/kg/day . For the 7 males the figure was 6.4 mg/kg/day and for the 4 females 4.5 mg/kg/day . The difference between sexes was not statistically significant. On applying the depletion theory, the average total daily size of the intestinal endogenous sterol pool was calculated as $1400 \pm 740 \text{ mg/day}$ on zero lipid intake. Of the 1400 mg, 380 mg was reabsorbed or was

ILL. 17:004-006; ILL. 05:004

Involved in the enterohepatic circulation of sterol. The total capacity of the intestine to absorb cholesterol on a low fat diet was 2 g/day of dietary or exogenous cholesterol plus 0.98 g/day of endogenous sterol, or 2.98 g/day. The average total daily synthesis of cholesterol by the body was calculated to be 2100 mg, the amount catabolized being 1680 mg. Assuming that 87% of the cholesterol metabolized is converted to bile acid, then 1460 mg/day of cholesterol is converted to bile acid. The various parameters were calculated for a man weighing 70 kg and the confidence limits of the estimates are given. (Contractor's abstract)

Two new methods were used in the estimation of the endogenous intestinal sterol pool. A procedure called the "depletor method" which measures exclusively the quantity of cholesterol actually available for absorption yielded 17 mg/day/100 g rat for the size of the total intestinal pool of endogenous cholesterol. Another procedure called the "balance method" by which the entire amount of cholesterol excreted in the feces is measured gave a value of 15 mg/day/100 g rat. Both methods are discussed and compared with the radioactive cholesterol method.

ILL. 17:004

Illinois U. Dept. of Clinical Science, Chicago.

EFFECT OF PALMITIC AND STEARIC ACID ON CHOLESTEROL ABSORPTION IN MAN, by E. Karvinen, T.-M. Lin, and A. C. Ivy. [1957] [13]p. incl. tables, refs. (AFOSR-TN-57-215) (AF 18(600)1580) AD 126513
Unclassified

Also published in Jour. Appl. Physiol., v. 11: 8-11, July 1957.

This study on human subjects was made because it had been found in rats that stearic and palmitic acid were poorly utilized and impaired the intestinal absorption of cholesterol. Fifteen young healthy adult humans were fed a basal diet containing 20 g of fat (10 g vegetable and 10 g of animal), 120 g of protein, and 490 g of carbohydrate daily. The fecal excretion of cholesterol and total lipid was determined during the last 3 days of eight 7-day dietary periods. Nine subjects consumed the basal diet (BD) for one week, then the BD plus 30 g/day of palmitic acid, then the BD plus one egg/day (300 mg of cholesterol), then the BD plus one egg plus 30 g of palmitic acid. Six subjects followed the same routine, except that 30 g of stearic acid replaced the palmitic acid and 3 g of cholesterol were fed instead of egg. The absorption of the endogenous and the dietary cholesterol was not influenced significantly by either fatty acid. The palmitic and the stearic acid were utilized by the human subjects to the extent of 55% and 21%, respectively. Comparison is made between the results of this study and similar observations made on the rat.

ILL. 17:006

Illinois U. Dept. of Clinical Science, Chicago.

CHOLESTEROL METABOLISM. THE EFFECT OF PALMITIC AND STEARIC ACID AND OF NICOTINIC ACID ON THE DEVELOPMENT OF EXPERIMENTAL ATHEROSCLEROSIS IN THE CHICK, by A. C. Ivy, E. Karvinen, and T.-M. Lin. Final rept. Oct. 1, 1955-Sept. 30, 1956. Apr. 1, 1957 [19]p. incl. tables. (AFOSR-TR-57-30) (AF 18(600)1580) AD 126468 Unclassified

This study was undertaken because it had previously been found that palmitic and stearic acid, when fed as the sole source of lipid in the diet, markedly decreased the absorption of dietary cholesterol in the rat. This was apparently due to the poor utilization of these fatty acids by the rat. In the present experiment, it was observed that palmitic acid and nicotinic acid ameliorated experimental atherosclerosis in the chicken caused by the feeding of cholesterol. Stearic acid, however, had no significant effect on the atherosclerosis.

ILL. 05:004

Illinois U. [Dept. of Mathematics] Urbana.

FIXED POINTS AND OTHER SPECIAL POINTS AND POINT SETS UNDER MAPPING, by D. G. Bourgin [1958], 49p. incl. refs. (AFOSR-TR-58-146) (AF 18(603)32) AD 205093; PB 139606 Unclassified

Discussions on a variety of problems connected with mappings are presented. A general theorem on a common image point for a special mapping of a space admitting 2 periodic homeomorphisms is discussed. Several considerable generalizations of the results of the theorem of Bagemihl (Fund. Math., v. 40: 3-12, 1953) are obtained, and a more direct argument is given pivoting on index theorems. Based on separation arguments for manifolds, it has been established that under deformation of circles, various special point pairs move along the continua. At some stage of the deformation of an n sphere, its intersection with a fixed sphere must contain n orthogonal n tuples of antipodal point pairs and the mapping of such an n tuple. Proof of a lemma on putative carriers of certain cycles on a torus, which is applicable to other types of manifolds, is presented and is used to give results on a

ILL. 17:005

Illinois U. Dept. of Clinical Science, Chicago.

ESTIMATION OF THE ENDOGENOUS INTESTINAL STEROL POOL IN RAT BY MEANS OF TWO METHODS, by E. Karvinen, T.-M. Lin, and A. C. Ivy. [1957] [10]p. incl. table. (AFOSR-TN-57-216) (AF 18(600)1580) AD 126514
Unclassified

Also published in Gastroenterology, v. 33: 789-793, Nov. 1957. (Title varies)

ILL. 06:002-004; ILL. 17:003-004

common image point of doubly periodic real valued functions for certain 4-point configurations, and a derived result is given for a mapping of a 2-point sphere. Consideration of the cohomology ring of a quotient space of a Stiefel manifold and a monotone property of an index under symmetric maps are used to obtain the first general inequality relating the values of n, p , and m in order that there always be an orthogonal p tuple of points on an S^n mapping into a single point of E^m for an arbitrary map of S^n to E^m .

ILL.06:002

Illinois U. [Dept. of Mathematics] Urbana.

CONDITIONAL BROWNIAN MOTION AND THE BOUNDARY LIMITS OF HARMONIC FUNCTIONS, by J. L. Doob. Oct. 31, 1957, 40p. incl. refs. (AFOSR-TN-57-625) (AF 18(603)11) AD 136728 Unclassified

Also published in Bull. Soc. Math. de France, v. 85: 431-458, 1957.

Functions and stochastic processes on a Green space R are discussed as defined by Brelot and Choquet, except that the dimensionality 2 is not made exceptional (so that Riemann surfaces are excluded) and that points at infinity are excluded. A general situation is studied for a procedure of revitalizing generalized harmonic function which is discussed for its implications in the study of the Dirichlet problem by probability methods. Conditional Brownian motion processes are studied and the concept of Naim's fine limit at a point of R is analyzed. A variation of Fatou's boundary value theorem is proved for a probabilistic interpretation.

ILL.06:003

Illinois U. [Dept. of Mathematics] Urbana.

PROBABILITY THEORY AND THE FIRST BOUNDARY VALUE PROBLEM, by J. L. Doob. Oct. 31, 1957, 29p. (AFOSR-TN-57-627) [AF 18(603)11] AD 136729 Unclassified

Also published in Illinois Jour. Math., v. 2: 19-36, Mar. 1958.

The place of the relativized first boundary problem for a class of regular functions, used in studies of harmonic functions on a Green space, is discussed. Boundary limit properties of extremal and minimal regular functions are obtained. A characterization in probability terms of upper and lower first boundary value problem solutions is obtained which makes possible the resolutive functions. The characterization implies that if the domain of the functions has a compact

closure in the defining space, every continuous boundary function is resolutive.

ILL.06:004

[Illinois U. Dept. of Mathematics, Urbana.]

BOUNDARY LIMIT THEOREMS FOR A HALF-SPACE, by J. L. Doob. [1958] [8]p. [AF 18(603)11]

Unclassified

Published in Jour. Math. Pures Appl., v. 37: 385-392, Oct.-Dec. 1958.

The present theory is illustrated by the example of a Euclidean half space R ; one can then specify the density of transition of the Brownian movement on R and the Green's function of R , and find, as a special case, a theorem from J. Lelong-Ferrand.

ILL.07:003

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THE NONSATURABILITY OF THE STRAIN FIELD OF A DISLOCATION BY POINT IMPERFECTIONS, by R. Thomson. July 15, 1957, 18p. (Rept. no. MEDUI-19-AF) (AFOSR-TN-57-266) (AF 18(600)1311) AD 126565 Unclassified

Also published in Acta Metallurgica, v. 6: 23-28, Jan. 1958.

It is shown that a dislocation strain field is not saturated by point imperfections when the dislocation dilatation is exhausted. Elastic saturation effects are possible due to the direct elastic interaction between the point imperfections, but are probably rare. The saturation problem is equivalent to the problem of nucleation of precipitates, and thus should be discussed in terms of the short range non-linear and electronic forces between the imperfections.

ILL.07:004

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THE MECHANICAL PROPERTIES OF METALS AT LOW TEMPERATURES, by H. M. Rosenberg. Oct. 15, 1957, 31p. incl. tables, refs. (Rept. no. MEDUI-20-AF) (AFOSR-TN-57-666) (AF 18(600)1311 and AF 18(603)22) AD 136655 Unclassified

Also published in Metallurgical Rev., v. 3: 357-379, 1958. (Title varies)

ILL.07:005 - ILL.07:008

Results are presented of a review of the literature on the mechanical properties of metals at low temperatures. The strength is usually enhanced rather than impaired down to the temperature of liquid He, 4.2°K, and it is only in a few metals that brittleness sets in. Elasticity, creep, fatigue, and internal friction are also considered. Experiments show that there is usually a slight increase (about 10%) in the elastic constants between room temperature and 4.2°K, and most of this occurs above 90°K. Most low temperature experiments have utilized ultrasonic techniques; either the resonant frequency or the transit of high frequency pulses through the specimen are measured. With few exceptions the tensile strength of all face centered cubic and hexagonal metals increases quite considerably below room temperature and even below 20°K. The tensile strength of Al increases about 4 times between room temperature and 4.2°K and that of most of the other metals is doubled. For metals in which a decrease in temperature produced a large change in the tensile strength, there was a correspondingly large change in the fatigue strength.

ILL.07:005

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

HABIT PLANES OF MARTENSITE IN CHROME-CARBON STEEL, by H. M. Otte and T. A. Read. [1957] [6]p. incl. illus. diagrs. table, refs. (AF 18(600)1311)

Unclassified

Published in Jour. Metals, v. 9: 412-417, Apr. 1957.

Observations are reported on the scatter of the habit planes of martensite in a 2.8% Cr, 1.5% C steel. Only a small amount of the scatter is actually due to experimental error; most of it is real. Possible reasons for the real scatter are proposed and examined. (Contractor's abstract)

ILL.07:006

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

GRAPHICAL ANALYSIS OF DIFFUSIONLESS PHASE CHANGES - THE CUBIC TO TWINNED ORTHORHOMBIC TRANSFORMATION, by D. S. Lieberman, T. A. Read, and M. S. Wechsler. [1957] [10]p. incl. illus. diagrs. [Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1311, and Atomic Energy Commission]

Unclassified

Published in Jour. Appl. Phys., v. 28: 532-541, May 1957.

A simplified method of calculating the crystallographic features of a diffusionless (martensitic) phase change is described and applied to the gold-cadmium alloy cubic-

orthorhombic transformation. Use of the method requires a knowledge of the initial and final crystal structures and the specification of the crystallographic plane and direction of the inhomogeneous shear. It is based on the requirement that after partial transformation the interface between two phase be free from stress on a macroscopic scale. The method involves representing on a stereographic net (a) the loci of directions in the original phase unchanged in length by the structure per se and (b) the loci of directions unchanged in length by the inhomogeneous shear. The intersection of these loci determine possible undistorted interface planes. Excellent agreement with experimental observations is found when the method is applied to the cubic-orthorhombic transformation in gold-cadmium alloys. (Contractor's abstract)

ILL.07:007

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

MARTENSITIC TRANSFORMATIONS AND DETERMINATION OF THE INHOMOGENEOUS DEFORMATION, by D. S. Lieberman. Mar. 15, 1958, 1v. incl. diagrs. tables, refs. (Rept. no. MEDUI-18-AF) (AFOSR-TN-58-76) (AF 18(600)1311) AD 148124

Unclassified

Presented at meeting of the Fourth Congress of the Internat'l. Union of Crystallography, Montreal, Canada, July 1957. (Title varies)

Also published in Acta Metallurgica, v. 6: 680-693, Nov. 1958.

A simple graphical method is presented for determining directly from observations of the crystallographic features of a martensitic transformation, the inhomogeneous deformation which is part of the total transformation distortion. The method involves reversing the usual solution of the problem from the crystallographic data to a prediction of the transformation mechanism and determines uniquely that pattern of inhomogeneity which could produce that particular set of crystallographic features. The technique is a more elegant and much shorter version of the previous graphical formulation of the Wechsler-Lieberman-Read theory of martensitic transformations. The correctness and utility of the theory is substantiated, and the inverse method is applied to the f.c.c. to b.c.t. austenite-martensite transformation in an Fe-Ni-C alloy for which accurate data are available.

ILL.07:008

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THEORY OF DISLOCATION CLIMB, by R. Thomson. Sept. 1958 [61]p. incl. diagrs. refs. (AFOSR-TN-58-827) (AF 18(600)1311) AD 202912

Unclassified

ILL. 07:009; ILL. 18:001

A theory of dislocation climb is presented for the case where the crystal possesses a supersaturation of vacancies (or interstitials). The equations governing the climb process describe the jog populations and the nucleation of new jogs by the vacancy supersaturation. The same equations can be used to derive the jog population on a dislocation network at equilibrium and yields a result which is not a simple Boltzmann factor solution. A model is constructed for the nucleation of jogs in dislocations which are split into partials. The model predicts the slow climb of split dislocations as compared with whole dislocations. The case of high supersaturation typical of a quenching experiment is compared to the low supersaturation of an annealing process, and the jog production process peculiar to high supersaturation is discussed. It is suggested that impurities should play only a minor role in jog nucleation, but should be concentrated at the nodal points of the network by the climb process. It is, however, possible under conditions of high supersaturation for the nodal points to act as jog sources and multipliers, and this possibility suggests one reason why a dislocation network wall can be a particularly good sink for vacancies if the supersaturation is high. Detailed numerical results are difficult to predict because of the lack of information concerning the basic parameters of the theory. One of these parameters is the mobility of a vacancy along the dislocation. An attempt is made to interpret the results of the pipe diffusion data to obtain the mobility of the vacancy. The discussion leads to some interesting constraints on the configuration of the core of the dislocation which require a net volume change in the crystal due to the presence of the dislocation. The estimated volume change in copper is approximately $1/2$ atomic volume per atom length of dislocation. Finally, in an appendix, a solution is obtained for the diffusion of vacancies in the presence of a dislocation sink where the solution includes the force terms between the vacancies and the dislocation. (Contractor's abstract)

ILL. 07:009

Illinois U. [Dept. of Mining and Metallurgical Engineering]
Urbana.

INVESTIGATION OF THE CRYSTALLOGRAPHY OF DIFFUSIONLESS PHASE CHANGES IN STEEL, by C. M. Wayman. Final rept. Aug. 31, 1958, 9p. incl. refs. [Rept. no. MEDUI-20-AF] (AFOSR-TR-58-121) (AF 18-600)1311; continued by AF 49(638)420 AD 202922; PB 138654
Unclassified

Experiments were performed to obtain fundamental information about the martensite transformation in steels. An x-y double micrometer positioning device was designed for locating a predetermined area in an x-ray beam. Orientation relationships were determined on an alloy containing 22% Ni-0.8% C which were in agreement with those reported in literature. Similar experiments with an Fe-30% Ni alloy failed to yield Laue patterns that could be used for orientation relationships.

The very few and diffuse spots indicated that the martensite plates in this alloy are imperfect, and that theories based on a homogeneous distortion are invalid. Attempts to produce large single crystals and a single interface transformation in the Fe-30% Ni alloy were unsuccessful. The habit planes of 12 martensite plates were determined by a 2-surface analysis in an alloy containing 2.8% Cr and 1.5% C. A stereographic plot of the poles of these habit planes revealed them to lie between (225) and (259), referred to the austenite axes. Electron microscope studies revealed striations in the martensite plates that could indicate slip or twinning. A graphical method was developed for analyzing the martensitic transformations. Essentially, the method is a stereographic representation of the theoretical mathematical analysis of the transformation.

ILL. 18:001

Illinois U. Dept. of Mining and Metallurgical Engineering,
Urbana.

ANELASTICITY IN ALLOYS OF Cd AND Mg, by J. Enrietto and C. Wert. Aug. 6, 1957, 26p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-562) (AF 18(603)-22) AD 136547; PB 132588
Unclassified

Also published in Acta Metallurgica, v. 6: 130-132, Feb. 1958.

An investigation was initiated to determine whether damping might drop to zero in a MgCd system with 50% Mg and if so, the manner in which the damping falls from the high value reported by Lulay at 29% Mg to zero at 50% Mg (Acta Metallurgica, v. 4: 627, 1956). Specimens were prepared and analyzed with regard to the relative amounts of Mg and Cd by a double sulfate method described by Lulay in his thesis written at the University of Illinois in 1955. The internal friction rose from a minimum near zero at 25% Mg to a maximum of 0.13 at 29.3% Mg in an almost straight-line curve. The rise was followed by a sharp drop to a minimum at 31.6% and an equally sharp rise to another maximum of 0.146 at 33% Mg. From about 34 to 38.4% Mg there was a linear drop in the internal friction which is believed to be indicative of a 2-phase region, the phases being an ordered phase and a random solid solution. The variation of the peak temperature with composition was apparently oscillatory. It was concluded from the data that an ordered phase exists based on the MgCd superlattice extending from above 50 to 39% Mg. It was assumed that between 34 to 39% Mg a disordered phase exists. From 29 to 25% Mg, another 2-phase region exists consisting of the ordered compound MgCd_3 and the disordered phase. (ASTIA abstract)

ILL. 18:002; ILL. 19:001-003

ILL. 18:002

Illinois U. Dept. of Mining and Metallurgical Engineering,
Urbana.AGING IN Au-Ni ALLOYS, by J. Siversten and C. Wert.
Apr. 1, 1958 [33]p. incl. diagrs. (AFOSR-TN-58-368)
(AF 18(603)22) AD 154274 UnclassifiedAlso published in Acta Metallurgica, v. 7: 275-282,
Apr. 1959.

Measurements have been made of changes in some physical properties of quenched alloys of 70% Au-30% Ni when they were annealed at low temperatures. Changes in the electrical resistance, volume, and Young's modulus were observed to occur. They indicate that there is at least one metastable precipitate formed on low temperature annealing; it occurs about 10^4 times earlier than the main phase change which has been well studied previously. There is a critical temperature above which this low temperature phase is unstable; this is about 225°C. Exact description of the low temperature phase is not possible, but it does seem to be either (1) clusters of Au-rich or Ni-rich atoms or (2) regions of high geometrical order. Quenched-in vacancies are presumed to control the rate of the reaction but the precipitate is not thought to be simply clusters of vacancies. (Contractor's abstract)

ILL. 19:001

Illinois U. Dept. of Mining and Metallurgical Engineering,
Urbana.STRUCTURAL CHANGES IN SINGLE CRYSTAL
COPPER-ALPHA BRASS DIFFUSION COUPLES, by V.
Y. Doo and R. W. Balluffi. [1958] 35p. incl. illus.
tables, refs. (AFOSR-TN-57-747) (AF 18(603)106)
AD 136734 UnclassifiedAlso published in Acta Metallurgica, v. 6: 428-438,
June 1958.

Structural changes associated with Kirkendall diffusion in single crystal copper-alpha brass couples have been studied. Vapor-solid couples in which zinc was diffused into copper from the vapor were investigated using metallographic and x-ray techniques. The following effects were found under certain conditions in the diffusion zone: (1) dislocation formation; (2) arrangement of dislocations into sub-boundaries; (3) recrystallization and formation of new grains; and (4) twin formation. The dislocation density and fineness of substructure were greatest at the lowest diffusion temperatures. Recrystallization was found at low diffusion temperatures, and twin formation was always associated with recrystallization. An explanation of these phenomena is given in terms of the production and subsequent redistribution of dislocations by climb and slip mechanisms during diffusion. (Contractor's abstract)

ILL. 19:002

Illinois U. Dept. of Mining and Metallurgical Engineering,
Urbana.SELF-DIFFUSION IN SILVER DURING PLASTIC
DEFORMATION IN EXTENSION AND COMPRESSION,
by J. B. Darby, Jr., C. T. Tomizuka, and R. W. Balluffi.
July 1958 [33]p. incl. illus. diagrs. refs. (AFOSR-TN-
58-546) (AF 18(603)106) AD 158363 UnclassifiedAlso published in Jour. Appl. Phys., v. 30: 104-112,
Jan. 1959.

Self-diffusion of Ag^{110} in silver single crystals subjected to simultaneous deformation at 800 and 900°C was studied using the sectioning technique. The crystals were orientated for duplex slip and were deformed in extension and compression at constant strain rates from 1 to 28×10^{-5} per sec and total strains as large as 0.33 were attained. Recrystallization occurred in the initially single crystal specimens during diffusion-deformation under all conditions except tension at 800°C. The effect of straining on the rate of diffusion was found to be small in all cases. The straining changed the diffusivities by less than 50 percent, and it is concluded that the observed changes were probably within the experimental error. The results indicate that any increases in diffusion rate due to the generation of point defects or short circuiting paths during deformation were small. These conclusions are shown to be consistent with other experiments involving these phenomena. (Contractor's abstract)

ILL. 19:003

Illinois U. Dept. of Mining and Metallurgical Engineering,
Urbana.ON THE EFFECT OF NON-EQUILIBRIUM VACANCIES
ON THE KINETICS OF KIRKENDALL DIFFUSION, by
H. Fara and R. W. Balluffi. Sept. 1958 [18]p. incl.
diagrs. refs. (AFOSR-TN-58-690) (AF 18(603)106)
AD 162224 UnclassifiedAlso published in Jour. Appl. Phys., v. 30: 325-329,
Mar. 1959.

Vacancy diffusion models which predict parabolic diffusion-penetration kinetics implicitly assume that vacancy equilibrium is maintained everywhere. However, a non-equilibrium vacancy distribution is generally established by the pumping action of the chemical gradient in the Kirkendall effect. A more general diffusion model is, therefore, developed in which vacancies are not necessarily maintained in equilibrium. The behavior of the model is then investigated and non-parabolic kinetics are found. However, the kinetics approach those of the equilibrium model as either the vacancy lifetime approaches zero or as the diffusion time becomes very

ILL. 19:004-006; ILL. 08:008

long. The applicability of the equilibrium model, therefore, depends upon the particular system and diffusion time. Machine calculations using the equations of the non-equilibrium model are compared with experimental results and it is concluded that non-parabolic effects are probably of little importance in usual face-centered-cubic metallic systems by the time diffusion measurements are made by conventional sectioning methods; i.e., when $Dt > \sim 10^{-5} \text{ cm}^2$. (Contractor's abstract)

ILL.19:004

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

ON THE KIRKENDALL EFFECT IN THE HEXAGONAL CLOSE-PACKED PHASE OF CADMIUM AND MERCURY, by D. H. Killpatrick and R. W. Balluffi. Dec. 1958, 1v. incl. diagre. table, refs. (AFOSR-TN-58-1135) (AF 18-(603)106) AD 208084 Unclassified

Also published in Jour. Appl. Phys., v. 30. 443-450, Mar. 1959.

Sandwich type and vapor-solid type diffusion couples have been used to study marker movements, polygonization, and void formation in the hexagonal close-packed phase of a cadmium-mercury system. A strong marker shift was found to occur towards the alloy side of the sandwich couples indicating faster diffusion of mercury than cadmium. Extensive polygonization was found in the diffusion zones of the vapor-solid couples by x-ray methods. A few large isolated voids were found in the vapor-solid couples from which mercury has diffused out. The observed Kirkendall effect phenomena are qualitatively similar to those found in cubic systems which have been previously studied, and the results are consistent with a vacancy diffusion mechanism in the present system. (Contractor's abstract, modified)

ILL.19:005

Illinois U. [Dept. of Mining and Metallurgical Engineering] Urbana.

THE EFFECT OF SIMULTANEOUS PLASTIC FLOW ON SELF-DIFFUSION IN SILVER SINGLE CRYSTALS (Abstract), by J. B. Darby, [Jr.], C. T. Tomizuka, and R. W. Balluffi. [1958] 1p. [AF18(603)106] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 124, Mar. 27, 1958.

Buffington and Cohen found that self-diffusion in iron at 89°C was apparently increased by a factor of 15 applying a compressive strain rate of $\dot{\epsilon} = 0.27 \text{ hr}^{-1}$. This result

could conceivably be caused by the generation of point imperfections during deformation or by short circuiting along dislocations and internal cracks. We have carried out somewhat similar experiments on silver single crystals orientated for duplex slip. Ag^{110} was plated on (111) and (110) faces of the bar shaped crystals and the penetration curves were obtained by sectioning. The Gaussian curves showed no effect resulting from the deformation within the expected experimental error (measurement of the diffusivity to $\pm 20\%$) for $\dot{\epsilon} < + 0.2 \text{ hr}^{-1}$ at 900°C and $\dot{\epsilon} < 0.03 \text{ hr}^{-1}$ at 800°C. The total strains were < 0.35 . Changes in structure were also investigated, and at 900°C recrystallization occurred during the runs. Further experiments in compression are in progress.

ILL.19:006

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

ANALYSIS OF DIFFUSION IN MEDIA UNDERGOING DEFORMATION, by H. Fara and R. W. Balluffi. Dec. 1957, 4p. (AF 18(603)106) Unclassified

Also published in Jour. Appl. Phys., v. 29: 1133-1134, July 1958.

An investigation of diffusion in media undergoing plastic deformation has been carried out for the case of a rectangular parallelepiped which is being continuously deformed at a constant rate and for which the specimen surfaces are the principal planes of deformation. The boundary conditions assumed are those in which there are instantaneous plane sources at one or more surfaces with no impingement at the center. A solution for the instantaneous concentration is given in terms of a power series in the term $A_n x^2/4tD$, where D is the diffusivity constant, $\dot{\epsilon}_i$ are the constant strain rates along the principal axes, and $A_n = \sum_{k=1}^n a_k (\dot{\epsilon}_i t)^{n-k}$. The general power series solution is reduced in the special case, $\dot{\epsilon} = 0$, to the solution for the static diffusion problem.

ILL.08:008

Illinois U. [Dept. of Physics] Urbana.

EFFECT OF LOW TEMPERATURE PLASTIC DEFORMATION UPON THE OPTICAL PROPERTIES OF ALKALI HALIDES, by G. Chiarotti. Apr. 1957, 14p. diagre. refs. (AFOSR-TN-57-155) (AF 18(600)662) AD 126447 Unclassified

Also published in Phys. Rev., v. 107: 381-387, July 15, 1957.

ILL.08:009 - ILL.08:011

The optical absorption spectrum of KBr and KI crystals, which have been plastically deformed at low temperature, has been observed in the region of the α band in order to detect single ion vacancies generated by moving dislocations. As a result of the present experiment no α band has been observed in KBr and KI crystals plastically deformed at several temperatures between -180°C and -125°C . The number of α centers is estimated to be less than 10^{18} cm^{-3} for KBr or KI crystals after 5% of plastic strain. A general broadening of the fundamental absorption band takes place after plastic deformation. On the other hand a yellow photoluminescence can be excited in the spectral region of the broadened fundamental absorption. A rough proportionality exists between the amount of luminescence and the number of photons absorbed in the region of the crystal responsible for the extra-absorption. Annealing at room temperature reduces both luminescence and extra-absorption. A qualitative explanation is given, which is based on the present knowledge of defects in alkali halides. (Contractor's abstract)

ILL.08:009

Illinois U. [Dept. of Physics] Urbana.

IONIC CONDUCTIVITY AND DIFFUSION IN SILVER BROMIDE, by A. S. Miller. [1957] 1v. incl. diagrs. tables, refs. (AFOSR-TN-57-224) (AF 18(600)662) AD 126522 Unclassified

A study was made of the deviation between calculated and experimentally observed diffusion coefficients. Conductivity and self-diffusion measurements were made on single crystals of pure AgBr and on AgBr with added positive divalent Cd ions. The theory is developed and the experimental procedure is described. The results are tabulated and compared with other work in the field. An error analysis is also given. From a comparison of the data for the 2 cases of AgBr crystals, the deviation of the calculation from the observed diffusion coefficient can be separated from components caused by each defect type.

ILL.08:010

Illinois U. [Dept. of Physics] Urbana.

TRANSIENT PHOTOCONDUCTIVITY IN AgCl at ROOM TEMPERATURE, by F. C. Brown. July 1957 [38]p. incl. diagrs. tables, refs. (AFOSR-TN-57-366) (AF 18(600)-662) AD 132438 Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 120, Mar. 21, 1957.

Also published in Jour. Phys. Chem. Solids, v. 4: 206-216, 1958.

Consideration is given to transient rather than steady-state photoconductivity in the presence of mobile ionic defects. With fast-pulse techniques, it is possible to separate electronic from ionic currents and to observe primary photoresponse in essential agreement with a single trapping model. Polarization due to shift is discussed. Data are given on 20 Bridgman crystals. Pure AgCl grown in vacuum, chlorine, or an inert atmosphere, and from moisture-free material, and the products of hydrolysis (Ag and Ag_2O), showed relatively low photoresponse. Crystals grown in air, without filtering or in vacuum from a moist starting charge, showed larger photoconductivity and electron lifetimes on the order of microseconds. Electrical glow curve experiments on XVIII₃ crystals indicated that traps of thermal depth about 0.4 eV were present in highest concentration. The lifetime of an electron in a trap of this depth is about 1 msec at 300°K . Therefore, these states control the lifetime of electrons in the fast-pulse measurements as well as in experiments carried out at 77°K . Crystals which have a large range or lifetime at 300°K appeared to have similar properties when cooled slowly to liquid-N temperatures.

ILL.08:011

[Illinois U. Dept. of Physics, Urbana.]

PHOTOPRODUCTION OF V_1 CENTERS IN KBr CRYSTALS, by G. Chiarotti and N. Inchauspé. July 1957 [13]p. incl. diagrs. refs. (AFOSR-TN-57-367) (AF 18(600)662) AD 132439 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 186, Apr. 25, 1957.

Also published in Phys. Rev., v. 109: 345-347, Jan. 15, 1958.

KBr crystals have been irradiated with monochromatic light of a wavelength of $190\text{m}\mu$ at liquid nitrogen temperature. When an electric field is applied to the crystal and its temperature subsequently raised, a burst of current is observed at -130°C , which corresponds to the destruction of V_1 centers. Evidence is presented that F centers and V_1 centers are created simultaneously by absorption of photons in the tail of the fundamental band of the crystal.

ILL.08:012 - ILL.08:015

ILL.08:012

Illinois U. [Dept. of Physics] Urbana.

MOBILITY OF THE POLARON IN AgCl, by F. C. Brown and F. E. Dart. July 1957 [15]p. incl. diagrs. table, refs. (AFOSR-TN-57-368) (AF 18(600)662) AD 132440 Unclassified

Also published in Phys. Rev., v. 108: 281-284, Oct. 15, 1957. (Title varies)

Transit-time measurements of electron mobility in AgCl have been extended to very low temperatures. Results are presented for an air-grown Bridgman crystal and for a Kyropoulos crystal of high purity. A maximum mobility of about $250 \text{ cm}^2/\text{volt-sec}$ at 80°K was found for the former and a maximum of $480 \text{ cm}^2/\text{volt-sec}$ at 55°K for the latter. It appears that imperfections strongly influence the mobility at low temperatures. At intermediate temperatures the data are in best agreement with the theory of interaction with optical modes of vibration of the lattice from which it is found that $\mu_0 = 30(e^{280/T} - 1) \text{ cm}^2/\text{volt-sec}$. This corresponds to a polaron effective mass of $m^*/m_0 = 0.28$ where m_0 is the free electron mass.

ILL.08:013

Illinois U. Dept. of Physics, Urbana.

PHOTOCONDUCTION IN KBr AND KI CONTAINING F CENTERS, by N. Inchausti. [1957] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)662] and Office of Naval Research) Unclassified

Published in Phys. Rev., v. 106: 898-903, June 1, 1957.

Photoconductivity in potassium bromide and potassium iodide containing F centers has been investigated at 80°K . The product of the quantum yield and unit range has been measured over the spectral range from 2.0 to 5.8 eV with F-center concentrations between 10^{15} and 10^{17} cm^{-3} . Evidence is presented to show that the mechanism for the production of photoelectrons depends upon the photon energy and the concentration of F centers. Two mechanisms for the production of photoelectrons are suggested by the data: the ionization of F centers by excitons and direct optical ionization of F centers.

ILL.08:014

Illinois U. [Dept. of Physics] Urbana.

MOBILITY OF ELECTRONS IN THE SILVER HALIDES

by F. C. Brown. [1958] [5]p. incl. tables. [AF 18(600)-662] Unclassified

Presented at International School of Physics, Varenna (Italy), July 14-Aug. 3, 1957.

Published in Nuovo Cimento, Series X, Suppl., v. 7: 600-604, 1958.

A brief analysis is given of the experimental measurements that have been carried out on the low temperature electron mobility of AgCl in order to determine the electron-lattice interaction. Electron scattering by the optical modes of vibration of the lattice is supported by the data, in agreement with the theoretical model of Low and Pines.

ILL.08:015

Illinois U. Dept. of Physics, Urbana.

TRANSIENT PHOTOCONDUCTIVITY IN AgCl AT [LOW] TEMPERATURE, by R. Van Heyningen. Feb. 1958, 98p. incl. diagrs. tables, refs. (AFOSR-TN-58-124) (AF 18(600)662) AD 152151 Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill. Mar. 27-29, 1958.

Abstract published in Bul. Amer. Phys. Soc., Series II, v. 3: 127, Mar. 27, 1958.

Also published in Phys. Rev., v. 111: 462-471, July 15, 1958.

Primary photoconductivity has been investigated down to 6.5°K in single crystals of pure AgCl using low intensity, monochromatic light pulses and a sensitive electrometer. Results are presented which are in agreement with a theory of the transient response taking into account light absorption and electron trapping. The electron yield per absorbed photon (quantum efficiency) is found to be high, somewhat less than one, in the long-wavelength tail and through the first peak of optical absorption for all crystals and temperatures down to 6.5°K . These results agree with the proposed band scheme if allowances are made for direct and indirect transitions. Electron trapping properties are strongly dependent on sample preparation, but certain features are believed characteristic of the silver halides. Whereas the density of deep (0.5 eV) traps may be very low in well-annealed AgCl, a high density of very shallow ($< 0.1 \text{ eV}$) traps exists in the crystals prepared so far. Prominent electrical glow peaks have been observed at 15°K , 35°K , and 178°K . No evidence for hole mobility has been found and upper limits on possible hole ranges are given.

ILL.08:018 - ILL.08:019

ILL.08:018

Illinois U. Dept. of Physics, Urbana.

HALL EFFECT FOR ELECTRONS IN SILVER CHLORIDE, by K. Kobayashi and F. C. Brown. Aug. 1958 [28]p. incl. diagrs. tables, refs. (AFOSR-TN-58-743) (AF 18(800)882) AD 201509 Unclassified

Also published in Phys. Rev., v. 113: 507-513, Jan. 15, 1959.

Experiments were conducted to determine whether the drift mobility of electrons in single crystal AgCl at 60° to 100°K was due to scattering by imperfections or to multiple trapping effects, and to extend mobility data into the very low temperature range. A fast pulse technique was developed for making steady state dc measurements of the half voltage. A cryostat and 2 separate high-vacuum systems and manifolds were used for making the measurements. An analysis is given of the method of measurement. Three air-grown crystals of AgCl which contained heavy metal impurities of the order of parts in 10^7 were selected for the experiments. The magnitude of the Hall mobility computed from the change in the resistance was dependent upon the uniformity of the crystal with regard to trapping lifetime. The sign of the observed Hall effect in the crystals tested was negative. The results indicated that the Hall mobility for electrons released by light rises to very, very high values at low temperature indicating samples of high perfection. Holes apparently made little contribution, if any, to the Hall effect in crystals studied in agreement with separate experiments on transient photoconductivity. Electrons were scattered by both acoustical and optical vibrations depending upon the range of temperature. Magnetoresistance effects began to become important at the lower temperatures and higher magnetic fields. (ASTIA abstract)

ILL.08:017

Illinois U. Dept. of Physics, Urbana.

DICHROISM OF THE F AND M BANDS IN KCl, by H. Kanzaki. Sept. 1958 [6]p. incl. diagrs. tables. (AFOSR-TN-58-852) (AF 18(600)662) AD 203495 Unclassified

Also published in Phys. Rev., v. 110: 1063-1068, June 1, 1958.

The dichroism of the F and M absorption bands that can be produced by optical bleaching of the F band with polarized light at 87°K is critically dependent on the concentrations of F and M centers. The changes in half-widths and peak positions of the F and M bands that accompany the development of dichroism suggest that the F-band dichroism is due to a spatial association of F and M centers. It is probable that an excited F

center can transfer energy to a neighboring M center. Dichroism of the F and M bands can be produced at room temperature by optical bleaching of either band with polarized radiation. (Contractor's abstract)

ILL.08:018

Illinois U. [Dept. of Physics] Urbana.

DRIFT AND DIFFUSION OF PHOTOELECTRONS IN AgCl AT ROOM TEMPERATURE (Abstract), by F. C. Brown. [1958] [1]p. [AF 18(800)882] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 127, Mar. 27, 1958.

Although AgCl is an ionic conductor at 300°K it is possible to study transient photoconductivity by using short (0.2 μ sec) light pulses synchronized with pulses of applied voltage. Single crystals can be prepared in which electrons released into the conduction band by light remain free for times as long as 50 μ sec before being trapped in deep states. Holes appear to be immobile in AgCl and electron-hole recombination processes relatively unimportant. At low voltages photocurrent decay times are a direct measure of electron trapping times. These times are the same whether the crystal is illuminated in the volume or by strongly absorbed light near one surface (electrons separated from holes by electric field). At higher voltages a sheet of electrons can be injected at the cathode and collected at the anode. The transit times yield values of drift mobility about equal to Hall mobility. The spread in time of arrival at the anode is in agreement with the Einstein-Nernst relation relating diffusion constant and mobility only in the limit of low intensity. At high light intensity space charge effects increase the width of the observed collection pulse and cause it to be asymmetrical.

ILL.08:019

Illinois U. Dept. of Physics, Urbana.

SELF-DIFFUSION AND ELECTRICAL CONDUCTIVITY IN SILVER BROMIDE, by A. S. Miller and R. J. Maurer. [1958] [5]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-600)662] and National Science Foundation) Unclassified

Published in Jour. Phys. Chem. Solids, v. 4: 196-200, 1958.

The ionic conductivity and the self-diffusion coefficient of silver have been measured in silver bromide and in silver bromide-cadmium bromide single crystals between 20 and 380°C. There exists a range of temperature

ILL.09:005; ILL.10:002;
ILL.11:011-013

for crystals containing cadmium within which the ratio of the conductivity to the self-diffusion coefficient has the value of 1.25 which is predicted for the vacancy mechanism of diffusion by the Einstein relation as modified by the Bardeen-Herring correction. This result is in agreement with the assumption that divalent cadmium ions replace monovalent silver ions in the crystal lattice and introduce an equal number of silver-ion vacancies. These excess vacancies reduce the concentration of interstitial silver ions to a negligible quantity through the operation of the mass-action law. Under these conditions diffusion occurs only by the vacancy mechanism. Conductivity and diffusion data obtained with pure silver bromide crystals are in fair agreement with the more extensive data of Friauf. (Contractor's abstract)

ILL.09:005

Illinois U. Dept. of Physics, Urbana.

ENERGY-BAND STRUCTURE OF A HYPOTHETICAL CARBON METAL, by R. C. Casella. [1958] [7]p. incl. diagrs. tables, refs. (AF 18(600)689) Unclassified

Published in Phys. Rev., v. 109: 54-60, Jan. 15, 1958.

Energy bands are derived for a hypothetical crystal composed of carbon atoms arrayed in a single face-centered-cubic lattice by the method of orthogonalized plane waves (OPW). The bands are compared with those of diamond which have been obtained by Herman. It is shown that the hypothetical crystal is an almost perfect metal. A potential for atomic carbon in the ³P ground-state is computed within the framework of Slater's free-electron-exchange approximation. An analytical approximation to this potential is provided. Results of a general symmetry analysis, appropriate for application of the OPW method to any f.c.c. lattice, are given. The cohesive energy of the metallic crystal relative to that of diamond is discussed within the approximation employed. (Contractor's abstract)

ILL.10:002

Illinois U. Dept. of Physics, Urbana.

[SURVEY OF SOLID STATE SCIENCES PROGRAM IN WESTERN EUROPE] by F. Seitz. Final rept. Nov. 30, 1957, 3p. (AFOSR-TR-57-92) (AF 18(600)783) Unclassified

ILL.11:011

Illinois U. Electrical Engineering Research Lab., Urbana.

GRAPHICAL EXTRAPOLATION OF VOLTAGE CURRENT CHARACTERISTICS OF THERMISTORS, by E.

K. Weise and J. Reynolds. Dec. 1, 1957, 7p. incl. diagrs. (Technical note no. 10) (AFOSR-TN-57-796) (AF 33(038)12644) AD 148028 Unclassified

It was found that at each point of the voltage current characteristic of a thermistor the rise of temperature above the environmental temperature is directly proportional to the wattage. Using this relation, a simple graphical extrapolation method was derived. By it, any number of characteristics at arbitrary environmental temperatures can be found if two characteristics and the respective environmental temperatures have been measured. The limits of the method are discussed. (Contractor's abstract)

ILL.11:012

Illinois U. Electrical Engineering Research Lab., Urbana.

ABOUT THE EQUIVALENT CIRCUIT OF THERMISTORS, by E. K. Weise and B. P. Lathi. Nov. 1, 1957, 43p. incl. diagrs. tables. (Technical note no. 9) (AFOSR-TN-57-797) (AF 33(038)12644) AD 148029 Unclassified

An equivalent circuit for thermistors was developed and the elements were determined for a commercial bead type, both for alternating current and for direct current transients. The circuit contains an inductance for which values of several thousand henries were found. The dependence of the circuit elements upon the position of the operating point on the characteristic, upon frequency, and upon outside parameters, as voltage and series resistance, was determined. For a particular bead type thermistor critical frequencies of about 1 cps at an operating point with a current of 1 ma and of about 3.5 cps at 2 ma respectively were found. At these frequencies the thermistor displayed the behavior of a pure inductance in producing a phase shift of exactly 90° between voltage and current. Other investigators used the same equivalent circuit previously. Their considerations and data were compared with the findings of this work which shows progress over the earlier investigations especially in demonstrating the limits of the applicability of the equivalent circuit assumed. (Contractor's abstract)

ILL.11:013

Illinois U. Electrical Engineering Research Lab., Urbana.

PRINCIPLES OF THERMISTOR APPLICATION, by E. K. Weise. Dec. 15, 1957, 25p. incl. diagrs. table. (Technical note no. 7) (AFOSR-TN-57-798) (AF 33(038)12644) AD 148030 Unclassified

After a general treatment of the behavior of thermistors, the concepts of the isothermal and the nonisothermal temperature coefficients of resistance are

ILL. 11:014-016; ILL. 12:005

introduced. The first determines the change of resistance with temperature when the current is too small to produce a heating effect; it is constant for each individual thermistor. The second is variable with the parameters of a series circuit and can be made very large. Stability conditions on the voltage-current characteristic are derived for series circuits. Thermistors in balanced and unbalanced bridge circuits are considered by graphical methods. (Contractor's abstract)

ILL.11:014

Illinois U. Electrical Engineering Research Lab.,
Urbana.

ALIGNMENT CHART FOR THE RESISTANCE-TEMPERATURE CHARACTERISTICS OF THERMISTORS, by E. K. Weise. Jan. 20, 1958, 14p. incl. diagrs. (Technical note no. 12) (AFOSR-TN-58-12) (AF 33(038)12644) AD 148145 Unclassified

A graphical representation of the important specifications of thermistors is presented. Plotting the logarithm of the resistance of a thermistor vs the reciprocal absolute temperature yields a straight line. A graphical method is presented for representing the temperature coefficient of resistance.

BASIC AND APPLIED RESEARCH ON SEMICONDUCTORS, by E. K. Weise. Final rept. Feb. 28, 1958, 82p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-50) (AF 33(038)12644) AD 154200 Unclassified

Investigations of electric and magnetic properties of reduced (IIa) group titanates are reported which were made at the University of Illinois from 1950 to 1957. Sintered samples of Mg_2TiO_4 , MgTiO_3 , MgTi_2O_5 , CaTiO_3 , SrTiO_3 , and BaTiO_3 were measured at temperatures between -190°C and $+1,500^\circ\text{C}$ in inert atmospheres. The electric conductivity was measured between -190°C and $+1,500^\circ\text{C}$. Between $+20^\circ\text{C}$ and -190°C the Hall effect was measured. The behavior of magnetic susceptibility was investigated over a wide range of temperature and composition. The n-type donors were produced in the titanate lattice by partial reduction in gas mixtures containing hydrogen. The donor concentration was determined by weighing before and after reoxidizing heat treatment where possible. The electron mobility was determined from both conductivity and Hall effect data; the results were compared. Investigations of the resistance-temperature characteristics, the voltage-current characteristics, and the equivalent circuit of thermistors are discussed. (Contractor's abstract)

ILL.12:005

Illinois U. Electrical Engineering Research Lab.,
Urbana.

TEMPERATURE-RESISTANCE STUDIES OF EVAPORATED BISMUTH FILMS, by J. M. Galligan. Jan. 25, 1957, 46p. incl. illus. diagrs. tables. (Technical note no. 1) (AFOSR-TN-57-38) (AF 33(038)21255) AD 115076 Unclassified

Metallic elements while in thin film "state" exhibit many anomalous and unusual properties. Among these might be mentioned the temperature dependence of resistance. It has been found that when the temperature of some thin films is increased the resistance decreases. This temperature dependence upon film thicknesses, i.e., resistance was investigated. The investigation was carried out on evaporated films of bismuth. This investigation thus might help to understand how the process of conduction occurs in thin films. It was found that the temperature coefficient of resistance, α , was negative for those films which had a resistance in the range from 12 to approximately 400 ohm. Above 400 ohm α was positive. Thermal activation energies were obtained. For fresh films, they ranged from $+0.27$ to -0.09 electron volt, with the maximum value at a resistance of about 50 ohm and a value of zero near 400 ohm. Aging in air for one month had the effect of increasing all values of activation energy by about 0.07 electron volt.

ILL.11:015

Illinois U. Electrical Engineering Research Lab.,
Urbana.

HALL EFFECT MEASUREMENTS ON SOME ALKALI EARTH TITANATES, by E. K. Weise and M. C. Andrews. Jan. 1, 1958, 30p. incl. diagrs. tables. (Technical note no. 11) (AFOSR-TN-58-195) (AF 33(038)12644) AD 152228 Unclassified

Measurements of the Hall effect on sintered samples of Mg_2TiO_4 , MgTiO_3 , MgTi_2O_5 , CaTiO_3 , SrTiO_3 , and BaTiO_3 were made. Mobility and concentration of electrons were determined and compared with data obtained from resistivity measurements. Approximate values of the electron mobility in $\text{cm}^2/\text{v sec}$ as derived from the Hall effect data were as follows: 0.3 for CaTiO_3 ; 3.0 for SrTiO_3 ; 0.1 for BaTiO_3 . The values for the magnesium titanates are still lower, between 0.01 and 0.1. The equipment used is briefly described. (Contractor's abstract)

ILL.11:016

Illinois U. Electrical Engineering Research Lab.,
Urbana.

ILL. 12:006-008; ILL. 13:003

ILL.12:006

[Illinois U. Electrical Engineering Research Lab.,
Urbana.]

RESEARCH ON CONDUCTING THIN FILMS, by C. E.
Drumheller. Feb. 19, 1957 [4]p. [AF 33(038)21255]
Unclassified

Some of the areas of solid state research for which thin film techniques are uniquely suited are outlined. Four main qualities which distinguish evaporated films from bulk material are discussed: (1) the surface area per unit volume is substantially greater in thin films; (2) the complex physical structure of metal films implies a greater amount of macroscopic disorder per unit volume than is found in bulk; (3) the crystallite units of thin films are granular in size and can be made of the same order as the mean free path of conduction electrons; and (4) the grain boundary area per unit volume is unusually large, and points within the grain boundaries are never far from the free surface. Relevant studies of certain basic solid state problems suggested by each of the latter are cited.

ILL.12:007

[Illinois U. Electrical Engineering Research Lab.,
Urbana.]

STRUCTURE-DETERMINED PROPERTIES OF EVAPORATED BISMUTH FILMS, by C. E. Drumheller. Final technical rept. Apr. 15, 1958, 23p. incl. illus. diagrs. (AFOSR-TR-58-57) (AF 33(038)21255) AD 154280; PB 138059
Unclassified

Infrared and electrical studies made on evaporated bismuth films suggest that the observed characteristics are largely determined by the film structure. The films

were evaporated at 10^{-5} mm pressure onto cellulose nitrate substrates. Electron microscope examination shows that up to about 2000 Å thickness the films possess a single-layer polycrystalline structure. Thickness-resistance measurements and low frequency current noise studies indicate that the major contribution to the film resistance is from the grain boundaries. Temperature-resistance characteristics have been related to average crystallite size. The infrared studies indicate that there are two types of grain boundaries, namely, those which contribute to the conductivity and those which do not. This conclusion is also confirmed by electron diffraction effects. By taking into account the capacitance of the grain boundaries it is possible to explain the infrared characteristics. Calculations from the measurements give an initial grain boundary thickness of about 15 to 30 Å. (Contractor's abstract)

ILL.12:008

[Illinois U. [Electrical Engineering Research Lab.]
Urbana.]

RESISTANCE MEASUREMENTS IN THIN BISMUTH FILMS (Abstract), by J. M. Galligan and C. E. Drumheller. [1958] [1]p. [AF 33(038)21255]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 254, June 19, 1958.

Evaporated thin films of bismuth deposited on cellulose nitrate substrate have been studied. Measurement of the temperature dependence of resistance in films in the resistance range from 12-360 ohms showed that the resistance decreased with an increase in temperature. The maximum activation energy was about 0.027 electron volt in this resistance range. In the resistance range above 400 ohms the resistance increased with increasing temperature, with activation energies as low as 0.009 ev. The reason for this negative activation energy is not understood, but the measurements are reproducible and it is well outside experimental error. No simple model could be proposed to explain this negative activation energy in the absence of information about the density and type of electrical carriers. Aging the films in air, for one month, had the effect of increasing the activation energies.

ILL.13:003

[Illinois U. Electrical Engineering Research Lab.,
Urbana.]

THE KERR CELL AS A MICROWAVE FREQUENCY OPTICAL SHUTTER. 2. EXPERIMENTAL INVESTIGATION, by G. L. Clark, D. F. Holshouser, and H. M. Von Foerster. Mar. 1957, 173p. incl. illus. diagrs. tables, refs. (Technical note no. 1-2) (AFOSR-TN-57-114) (AF 18(600)1018) AD 120467
Unclassified

The generation of light pulses as short as 69 μ sec in duration at a repetition rate of six billion/sec has been achieved by the use of a specially designed electro-optic Kerr cell driven at microwave frequency. Since the operation of a Kerr cell at such frequencies involves electric fields which change so rapidly that the field cannot be considered constant even for the length of time required for light to travel the two or three in. length of a Kerr cell, a new theory of Kerr cell operation has been worked out which takes the transit time into account. The results of this analysis and the effect of the transit time upon Kerr cell behavior, including operation with combined ac and dc electric fields, are discussed. The properties of liquid dielectrics which are pertinent to an understanding of the Kerr effect are reviewed, with

ILL. 13:004; ILL. 14:005,006

particular attention to dipole orientation polarization and various theoretical and empirical methods of describing the behavior of liquid dielectrics in the region of molecular rotation dispersion. Measurements of the dielectric properties of nitrobenzene, a liquid exhibiting a very large Kerr effect, were carried out over a large frequency range, and the results of this work are reported, along with a comparison of the properties of nitrobenzene with those of carbon disulfide and an evaluation of their relative merits and limitations. The design of a microwave Kerr cell and the compromises inherent in the choice of geometry and dimensions, as well as the problems and techniques involved in the actual construction of a cell are described in detail. The optical and electrical system in which a Kerr cell functions, and the experimental procedures which were used in the investigation are summarized, including a method of using the electro-optic shutter to check its own operation and to prove the existence of microwave modulation of a light beam. Finally, the results of the measurements which were made concerning the operation of a Kerr cell driven at microwave frequency, and the variation of the instantaneous and average light transmitted by such a shutter are presented. (Contractor's abstract)

ILL.13:004

Illinois U. Electrical Engineering Research Lab.,
Urbana.

THE TIME ELEMENT IN PHOTOELECTRIC EMISSION, by D. F. Holshouser and H. M. Von Foerster. Final technical rept. May 16, 1958, 90p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-67) (AF 18(600)1018) AD 158274 Unclassified

Effort was made to measure the degree of photoelectric response of transmission-type cesium-antimonide photocathodes to light pulses of 100- μ sec duration. A measurement of the photoelectric response to light pulses of 170- μ sec duration was obtained by modulating the light from a FX12 type xenon flashtube with a specially designed Kerr cell shutter driven by pulsed 3 kmc/sec microwave power. The degree of modulation of the photoelectric emission produced in a 1P42 type phototube by the modulated light was obtained by using the photoelectron current to generate microwave power in a resonant cavity whose output can be measured. Results indicate that the photoelectric response time of cesium-antimonide photocathodes of the transmission type, under operating conditions of high peak illumination of short duration, was of the order of 1 μ sec. A useful and reliable modulated light source was realized which provided intense periodic 170- μ sec light pulses. Shorter pulses are attainable at the expense of brightness, and pulses as short as 10 μ sec could probably be achieved. A device for the detection of light modulated at microwave frequencies was developed. Its frequency limitation was the response

time of the photoelectric surface employed. (ASTIA abstract)

ILL. 14:005

Illinois U. Electrical Engineering Research Lab.,
Urbana.

EFFECT OF HEAVY DOPING ON THE SELF-DIFFUSION OF GERMANIUM, by M. W. Valenta and C. Ramasastri. [1957] [12]p. Incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)1310 and Motorola, Inc.) Unclassified

Presented at Symposium on Semiconductors of the A.I.M.E. Inst. of Metals Div., Feb. 20, 1956.

Also published in Phys. Rev., v. 106: 73-75, Apr. 1, 1957.

The germanium self-diffusion coefficients for intrinsic, heavily-doped n - and p-type germanium were measured at several temperatures. It was found that the self-diffusion coefficient is greater for heavily-doped n-type than for intrinsic germanium and that the self-diffusion coefficient for intrinsic germanium is greater than for heavily-doped p-type. If it is assumed that a vacancy acts as an acceptor and that germanium self-diffusion goes by the vacancy mechanism, the observed changes in the value of the self-diffusion coefficient with doping are in the direction and of the order of magnitude of changes calculated from the shift in the Fermi level alone. It is concluded that germanium self-diffusion probably proceeds by the vacancy mechanism. (Contractor's abstract)

ILL.14:006

Illinois U. [Electrical Engineering Research Lab.]
Urbana.

OPTICAL PHONON CONTRIBUTION TO CARRIER ENERGY LOSSES IN SEMICONDUCTORS (Abstract), by T. N. Morgan. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)-1310] and Signal Corps) Unclassified

Presented at meeting of the Amer. Phys. Soc., Notre Dame U., South Bend, Ind., June 20-22, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 265-266, June 20, 1957.

Measurements of deviations from Ohm's law in semiconductors in high electric fields give information about energy loss processes for energetic electrons and holes. Microwave fields have been used to heat the carriers and the resulting changes in dc resistance in germanium and silicon specimens at temperatures between 77°K and 300°K have been observed. The results are in disagreement with the theory of Shockley and others based on the

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Illinois U. [Electrical Engineering Research Lab.]
Urbana.

MEASUREMENT OF GERMANIUM SURFACE STATES
BY PULSED CHANNEL-EFFECT, by G. Rupprecht.
[Jan. 1958] [27]p. incl. diagrs. refs. [AF 18(600)1310]
Unclassified

Also published in Phys. Rev., v. 111: 75-82, July 1,
1958.

Densities, cross sections and activation energies of
several fast germanium surface states are inferred
from low temperature conductivity relaxations in a thin
diffused surface layer. Relaxations are induced by ap-
plication of a sudden reverse biasing pulse. The ob-
served rate of change of channel conductance as a func-
tion of temperature is analyzed in terms of a model
wherein the equilibrium surface Fermi level is pre-
sumed to remain in close proximity to a trap level.
The results indicate the existence of an electron trap
0.24 ev from the conduction band and two hole traps
0.17 ev and 0.22 ev from the valence band. (Contra-
ctor's abstract)

ILL.14:011

Illinois U. [Electrical Engineering Research Lab.]
Urbana.

EFFECT OF DOPING ON THE DIFFUSION OF IM-
PURITIES IN GERMANIUM (Abstract), by M. W.
Valenta. [1958] [1]p. [AF 18(600)1310] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago,
Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
102, Mar. 27, 1958.

The diffusion coefficients of indium, antimony, arsenic
and tin were measured in As-doped, intrinsic and Ga-
doped germanium over a temperature range from 760°C
to 880°C. Donor diffusivities in the As-doped (about
 10^{19} atoms/cm³) samples ranged from 1.3 to 2.4 times
the corresponding ones in intrinsic germanium, and
those in the Ga-doped (about 10^{19} atoms/cm³) ranged
from 0.55 to 0.65 times those of the intrinsic samples.
The acceptor diffusivity also changed with doping in
the same direction (greater in n-type than p-type ger-
manium), but the change was appreciably smaller than
that observed for donors. Likewise, tin has a larger
diffusion coefficient in n-type than p-type germanium.
The observed changes are in the direction predicted
by a vacancy mechanism in which the donors form
complexes with negative vacancies, and acceptors form
complexes with both neutral and negative vacancies.

The heavily-doped single crystals were prepared by W.
W. Tyler of the G. E. Research Laboratory.

ILL.14:012

Illinois U. [Electrical Engineering Research Lab.]
Urbana.

EFFECT OF DOPING ON THE DIFFUSION OF IMPURI-
TIES IN SILICON (Abstract), by M. F. Millea. [1958]
[1]p. [AF 18(600)1310] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago,
Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
102, Mar. 27, 1958.

The diffusivities of P, Sb, Sn and In in "intrinsic"
($\sim 10^{15}$ impurity atoms/cm³ or less), heavily doped n-
type ($\sim 5 \times 10^{19}$ atoms/cm³), and heavily doped p-type
($\sim 2 \times 10^{20}$ atoms/cm³) silicon have been measured to
obtain information on the way diffusion takes place. The
measured diffusivities of p and Sb in n-type are twice
their values in intrinsic silicon; their diffusivities in
p-type are one half those in intrinsic silicon. These
changes are in the direction expected for vacancy dif-
fusion. The diffusivity of Sn in n-type is about 50%
larger than in intrinsic, whereas in p-type it is about
equal to that in intrinsic silicon. Opposite changes are
found for the diffusivity of indium; it is about 6 times
larger in p-type and about 50% lower in n-type than in
intrinsic silicon. Possible diffusion mechanisms for
substitutional impurities in silicon are discussed in the
light of these and other data.

ILL.14:013

Illinois U. [Electrical Engineering Research Lab.]
Urbana.

MICROWAVE CARRIER HEATING AND IMPACT
IONIZATION OF IMPURITIES IN GERMANIUM (Ab-
stract), by K. Seeger. [1953] [1]p. [AF 18(600)1310]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago,
Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
112, Mar. 27, 1958.

Deviations from Ohm's law have been measured in
germanium between 80 and 300°K by extending the
method used by Morgan to microwave field intensities of
 10^4 v/cm. In agreement with dc measurements of Ryder
and others on n-type germanium, the resistivity increases

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with field intensity E and the drift velocity saturates at high fields. No distinct E^2 region occurs, contrary to Ryder's results. In the low-field region the effects of various carrier concentrations have been investigated. With zinc-doped germanium at 80°K a resistivity decrease has been observed even at microwave fields down to the order of 1 v/cm. In this region the resistivity change is proportional to the square of the field and may be due to hole heating in the impurity scattering range. The large resistivity decrease at fields near 10^4 v/cm is considered to be caused partly by impact ionization of holes from the 0.097 ev Zn acceptor level.

ILL.20:001

Illinois U. Electrical Engineering Research Lab.,
Urbana.

THEORETICAL AND EXPERIMENTAL EVALUATION OF THE REBATRON - A RELATIVISTIC ELECTRON BUNCHING ACCELERATOR, by I. Kaufman. Dec. 1, 1956, 312p. incl. illus. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-57-7) (AF 18(603)62) AD 115039 Unclassified

The development of sources of appreciable RF power in the 1 mm to 0.1 mm wavelength range of the electromagnetic spectrum has yet to be accomplished. A very promising approach to the problem is the coherent interaction with a circuit, or the direct radiation, of a tightly bunched, megavolt electron beam. Work on a device for producing such a beam has resulted in a compact relativistic electron bunching accelerator, designated the REBATRON. One form of rebatron consists of an electron gun followed by two 10 cm cavities that are powered by a megawatt source. Calculations have shown that it may be possible to achieve very short, high density electron bunches from this rebatron, corresponding to strong harmonic content of up to the two-thousandth harmonic of this 3000 mc/sec source. A direct measurement to verify the degree of bunching, involving the measurement to pulse times of 10^{-13} sec, has obvious complications. Fortunately, a change in one of the rebatron parameters that influences the bunching is accompanied by a change in the output electron momentum spectrum, so that the rebatron performance may be evaluated by correlation of computed with experimentally determined momentum spectra. Such a comparison between theoretical and experimental momentum spectra has yielded very satisfactory results and has resulted in the conclusion that, to a high degree, this rebatron operates as predicted. Beam coupling experiments at 72.2 kmc/sec (the 26th harmonic) has further confirmed this conclusion. This report describes the rebatron, calculations of its theoretical behavior and their results, the experimental methods used in the attempt to verify the computed results, and the experimental results obtained. (Contractor's abstract)

ILL.20:002

Illinois U. Electrical Engineering Research Lab.,
Urbana.

MEGAVOLT ELECTRONICS MILLIMETER WAVE COUPLING STRUCTURE RESEARCH AT THE UNIVERSITY OF ILLINOIS, by P. D. Coleman. [1957] [15]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)62 and Atomic Energy Commission under AT(11-1)392) Unclassified

Published in Proc. First Tri-Service Millimeter Wave Symposium, Army Signal Engineering Labs., Fort Monmouth, N. J., Sept. 10-11, 1957, p. 120-134.

The purpose of this research was to show that a bunched megavolt electron beam represents the highest power level, most non-linear element yet proposed for frequency multiplication. Pulsed powers of tens of kilowatts with a useable beam harmonic of 100 appear practical as demonstrated with S-band bunching accelerators. Further, it was shown that megavolt electronics makes possible at least three new types of coupling systems which can circumvent the frequency limitation problems encountered by conventional microwave tubes. The following topics are discussed: frequency multiplication with a non-linear element and with an electron beam; desirable beam characteristics; bunching characteristics of a practical S-band rebatron; types of megavolt electronics beam coupling structures; excitation of higher order modes; dielectric loading of a metal cavity; a dielectric harmonotron; Cerenkov coupling structures; and comparison of megavolt electronics beam coupling schemes.

ILL.20:003

Illinois U. Electrical Engineering Research Lab.,
Urbana.

DESIGN AND EVALUATION OF AN S-BAND REBATRON, by I. Kaufman and P. D. Coleman. [1957] [9]p. incl. illus. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)62 and Wright Air Development Center under AF 33(616)2449) Unclassified

Published in Jour. Appl. Phys., v. 28: 936-944, Sept. 1957.

A practical design of an S-band rebatron for producing a high power, bunched, megavolt electron beam, theoretically possessing harmonic current frequencies in the submillimeter range is presented. An indirect experimental method of evaluating the beam obtained from the rebatron, based on measuring momenta spectra, gives very satisfactory agreement with theory. The validity of this indirect method of beam analysis is strengthened by a measurement of the ratio of the 26th beam harmonic current amplitudes under two different

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sets of conditions determined experimentally by momenta spectra measurements. No highly critical tolerance conditions are encountered in the investigation. (Contractor's abstract)

ILL. 20:004

Illinois U. Electrical Engineering Research Lab.,
Urbana.

PRESENT STATE OF THE MILLIMETER WAVE GENERATION AND TECHNIQUE ART — 1958, by P. D. Coleman and R. C. Becker. 1958, 1v. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)62 and Atomic Energy Commission under AT(11-1)392) Unclassified

Presented at the I.R.E.-PGMTT Symposium, Stanford U., Calif., May 5-7, 1958.

Also published in I.R.E. Trans. of Professional Group on Microwave Theory and Techniques, v. MTT-7: 42-61, Jan. 1959.

Two of the few fruitful approaches to the low-millimeter and submillimeter wave generation problem appear to be frequency multiplication by means of nonlinear phenomena and frequency conversion by parametric systems. Current work on frequency multiplication using relativistic megavolt beams, crystal diodes, field emitters, ferrites, etc. is reviewed. A brief account of present efforts to extend conventional tubes below wavelengths of 3 mm is presented. Waveguide components used at 1 to 2 mm are described. (Contractor's abstract)

ILL. 21:001

Illinois U. Electrical Engineering Research Lab.,
Urbana.

SYNTHESIS OF VOLTAGE TRANSFER FUNCTIONS WITH RIGHT HALF PLANE ZEROS BY RC FEEDBACK NETWORKS, by J. J. Mikulski. Mar. 15, 1957, 17p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-57-166) (AF 49(638)63) AD 126461 Unclassified

Presented at the Third Midwest Symposium on Circuit Theory, Iowa State Coll., Ames, May 1958.

Also published in Proc. Third Midwest Symposium on Circuit Theory, Iowa State Coll., Ames, 1958, p. 9.1-9.23.

The synthesis of voltage transfer functions with complex poles and right half plane (RHP) zeros has been approached previously through the use of active feedback networks by Armstrong and Reza, and Sallen and Key. In their studies, zeros are realized by passive

RC networks and are thereby limited in their location in the s plane. Feedback was employed to realize complex poles. In no instance was a zero on the positive real axis realizable. In these previous studies, the configuration was limited to proportional or RC passive network feedback. By utilizing a more general feedback function, one with RHP poles resulting from an unstable minor loop, a zero of $W(s)$ is realized in the RHP. This problem is investigated and design equations are given for system parameters to realize any $W(s)$. A numerical example illustrates the method. System sensitivity to parameter variation is briefly investigated and optimum conditions chosen for design.

ILL. 21:002

Illinois U. Electrical Engineering Research Lab.,
Urbana.

TRANSFER FUNCTION SYNTHESIS WITH ACTIVE ELEMENTS, by F. F. Kuo. Apr. 15, 1957, 19p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-57-206) (AF 49(638)63) AD 126503 Unclassified

Presented at the National Electronics Conference, Chicago, Ill., Oct. 7-9, 1957.

Also published in Proc. National Electronics Conference, v. 13: 1049-1056, 1957.

A synthesis procedure is given for synthesizing both minimum and non-minimum phase transfer functions using canonical RC structures which realize complex zeros of transmission. The use of RC sections to produce complex zeros of transmission is based upon a method due to Dasher. However, Dasher's method is restricted to the synthesis of minimum phase networks only. With the aid of active networks and canonical RC sections, it is possible to realize transfer functions which are not possible by Dasher's method. The active network representation used is the controlled-source-RC network which is equivalent to a transistor-RC-network. The partitioning theorem is used to remove the canonical RC structure.

ILL. 21:003

Illinois U. Electrical Engineering Research Lab.,
Urbana.

SYNTHESIS OF ACTIVE NETWORKS WITH NEGATIVE IMPEDANCE CONVERTERS, by R. T. Chien. May 5, 1953, 60p. incl. diagrs. refs. (Technical note no. 4) (AFOSR-TN-58-494) (AF 49(638)63) AD 158304; PB 137068 Unclassified

The Linvill configuration is used to synthesize second-order, non-positive-real, driving-point functions. Synthesis is accomplished by the use of a surplus factor. With the arbitrariness of the surplus factor, one

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is able to control the driving-point function. The existence of the solution in all cases is demonstrated and the minimum number of elements property of the solution is proved. It is shown that only five elements are required besides the negative impedance converters (NIC). RC networks are used in some cases and RL networks are used in the remaining cases. The synthesis of a transfer function together with the driving-point function is accomplished by application of Cauer's method of partial removal of poles. Useful results are obtained in synthesizing the transfer voltage ratios with different terminations, including the case of open output terminals. The conditions of realization are obtained and given in terms of coefficients. The method used is further extended to realize all three functions. Necessary and sufficient conditions are found for three functions to be a realizable set. The synthesis itself is carried out in the same manner as in the previous cases. For higher order functions, a procedure is outlined to find the desired pole positions by cut and try, for the synthesis of a driving-point function, or a driving-point function together with a transfer function. (Contractor's abstract)

ILL.21:004

Illinois U. Electrical Engineering Research Lab.,
Urbana.

POLE-ZERO SENSITIVITY IN NETWORK FUNCTIONS,
by F. F. Kuo. May 1, 1958, 78p. incl. diagrs. refs.
(Technical note no. 3) (AFOSR-TN-58-495) (AF 49(638)-
63) AD 158305; PB 137069 Unclassified

Also published in part in I.R.E. Trans. of Professional
Group on Circuit Theory, v. CT-6, 131, Mar. 1959.
(Title varies)

Also published in part in I.R.E. National Convention
Record, Pt. 2: 18-22, 1959. (Title varies)

If a network contains a variable parameter x (capacitance, or g_m of a vacuum tube, etc.), the polynomials of the driving-point and transfer functions describing the network have coefficients which are linear functions of x . The roots of the polynomials are also functions of x . Since the locations of the poles and zeros of these network functions are important in both analysis and synthesis of the network, it is desirable to know quantitatively the tendency for a root to vary with the parameter x . A measure of this tendency to vary is provided by the sensitivity function $S = dp/dx$, where p is a root of a polynomial. Properties and theorems pertaining to this sensitivity function are given in this work. Root sensitivity and the root locus of the polynomial are closely related topics. Sensitivity is shown to be the residue of a pole of a specialized form of the root locus equation whose poles are the roots of the given polynomial. From the properties of this special root locus form, it is shown that intersections of root loci have

infinite sensitivities. Other cases of infinite sensitivity figures are studied. The sum of the sensitivities of the roots of any polynomial is derived, and some properties are given as related to certain defined classes of polynomials. Numerical examples computed on ILLIAC are given to illustrate sensitivity properties of representative root loci. The sensitivity properties described above are applied to the analysis and synthesis of RC networks. In network analysis, several theorems pertaining to the sensitivity of double zeros of transmission and to a class of insensitive elements are given. The sensitivity factor is introduced in the synthesis of RC ladder networks by the Cauer procedure. Several sensitivity criteria are given for the synthesis of optimum RC ladder networks. Finally, a study is made of certain sensitivity properties of closed-loop feedback networks. A number of suggested problems for further study are given. (Contractor's abstract)

ILL.21:005

Illinois U. Electrical Engineering Research Lab.,
Urbana

ANALYSIS OF NONRECIPROCAL NETWORKS BY
DIGITAL COMPUTER, by W. Mayeda and M. E. Van
Valkenburg. [1958] [6]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)63] and Office of Ordnance Research)
Unclassified

Presented at I.R.E. National Convention, New York,
Mar. 24-27, 1958.

Published in I.R.E. National Convention Record, Pt. 2:
70-75, 1958.

In a previous paper (W. Mayeda and M. E. Van Valkenburg, I.R.E. WESCON Convention Record, Pt. 2: 137-144, 1957) the advantages of the digital computer in the analysis and synthesis of passive networks were described. The present paper extends this work to include linear nonreciprocal networks in which the current of a branch depends not only on the voltage of that branch, but might also be unilaterally dependent upon the voltage of other branches in the network. The topological formulas are presented in a form convenient for digital computer programming. Features of the program are outlined, and the advantages of speed and accuracy are illustrated by several examples which include stability and sensitivity considerations.

Imperial Coll. of Science and Tech. (Gt. Brit). see
London U. Imperial Coll. of Science and Tech. (Gt. Brit).

INU.01:001, 002; INN.02:002;
IRS.01:001; IAS.04:002

INU.01:001

Indiana U. Dept. of Chemistry, Bloomington.

A DIGITAL PULSE INTEGRATOR FOR FLASH MEASUREMENTS, by H. H. Kramer and E. J. Bair. Aug. 29, 1958 [12]p. incl. diags. (AFOSR-TN-58-777) (AF 18(603)93) AD 201925; PB 138173 Unclassified

Also published in Jour. Opt. Soc. Amer., v 50: 807-810, June 1960.

A digital pulse integrator is described for measuring the voltage-time area of electrical impulses such as the photocurrent resulting from the photoelectric observation of a xenon flash source. As the basis of its operation, the positive pulse to be integrated charges a capacitor. A decade scaler is used to count the number of smaller negative pulses from a crystal oscillator that are required to discharge the capacitor to its original voltage. A specific circuit was tested with square pulses having an adjustable amplitude and duration. The observed count is proportional to the pulse area with an accuracy and reproducibility greater than 0.3% for an individual pulse in the range 10- to 100-msec volts (with 45- to 100-v amplitudes). Limitations and applications of this type of integration are discussed briefly.

INU.01:002

Indiana U. Dept. of Chemistry, Bloomington.

A STROBOSCOPIC FLASH SOURCE FOR KINETIC SPECTROSCOPY, by J. H. Current, O. F. Raper, and E. J. Bair. Aug. 29, 1958 [9]p. incl. diags. (AFOSR-TN-58-778) (AF 18(603)93) AD 201926; PB 138172 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 50: 668-671, July 1960.

A stroboscopic light source is described for observing the kinetic behavior of chemical systems by absorption spectroscopy. The light consists of a short train of flashes in an accurately timed sequence. Such a system takes advantage of the brilliance of the xenon flash source while at the same time making it possible to observe the system at a sequence of times. Accurate timing is inherent in the apparatus. (Contractor's abstract)

INN.02:002

Innsbruck U. Inst. of Experimental Psychology (Austria).

ORIENTATION BY AURAL CLUES, by I. Kohler. [1957] [16]p. incl. illus. diags. refs. (AFOSR-TR-57-54) (AF 61(514)889) AD 136462 Unclassified

Also published in Naturwissenschaftliche Monatsschrift, no. 6/7: 1-16, May 1957.

Research has been performed to determine the possibilities and limits of orientation by means of sound. The ear is considered as a "receiver" and an "interpreter." Sound projectors are developed to facilitate controlled investigation as well as actually to improve conditions for orientation by sound. The so called 'obstacle sense' of blind persons is based on modifications of sound produced by reflection from nearby objects. Results show that the most effective guiding sounds are those emitted from the observer himself and that the obstacle sense can be awakened and developed to maximum efficiency by training.

IRS.01:001

Institut de Recherches Scientifiques et Techniques du Centre-Quest, Poitiers (France).

RESEARCH ON DEVELOPMENT OF A METHOD FOR MEASURING SURFACE TEMPERATURES. Final technical rept. Feb. 1958 [55]p. incl. illus. diags. (Rept. no. IRST 55-13) (AFOSR-TR-58-88) (AF 61-514)1193) AD 162109; PB 140449 Unclassified

An attempt was made to measure the wall temperature of a body at temperatures above 40°C by means of color changes in fluorescent lights. Numerous phosphors were investigated by use of a scanner device (slit and phototube) which was fixed on a wain and guided by 2 slides, all of which was attached to the spectrograph and enclosed in a light-tight box. Data indicated that the thermal sensibility of the fluorescent emissions can be used up to 450°C. (ASTIA abstract)

IAS.04:002

Institute for Advanced Study, Princeton, N. J.

A GENERALIZED FUNCTION-THEORY AND THE RELATED DIRICHLET PROBLEM. PART II, by J. Sanders. [1957] [14]p. (AF 18(600)791) Unclassified

Published in Ann. Math., v. 66: 141-154, July 1957.

In the first paper of this series (item no. IAS.04:001)

the author considered the equation $N^2(u) = 0$ and constructed a function theory related to this equation. The present paper is devoted to the solution of the Dirichlet problem for the equation $N^2(u) = 0$. The method used is patterned after the "double layer potential" method of solving the Dirichlet problem for Laplace's equation. G. Lauricella [Acta Math., v. 32: 201-256, 1909] and K. Schröder [Math. Z. v. 48: 553-675, 1943] employed a similar idea in dealing with the Dirichlet problem for the biharmonic equation. The author proceeds differently, using the function theory which he developed in his first

IAS.05:014 - IAS.05:017

paper. It is shown that the Dirichlet problem in question is equivalent to the determination of a certain Σ_2 -monogenic function from its values on the boundary. The main result concerns the Dirichlet problem which consists of finding a solution u of $N^2(u) = 0$, of class C^4 in a domain D , of class C^1 in the closure of D , which on the boundary C of D satisfies $u = f(s)$, $\partial u / \partial n = g(s)$, where f and g are given continuous functions of the arc length s on C . It is found that this problem possesses one and only one solution, under suitable differentiability assumptions relative to the boundary C and the functions σ and τ . (Math. Rev. abstract)

IAS.05:014

Institute for Advanced Study, Princeton, N. J.

APPLICATION OF HILBERT SPACE METHODS TO LIE GROUPS ACTING ON A DIFFERENTIABLE MANIFOLD, by J. Lelong-Ferrand. Dec. 1956, 6p. (AFOSR-TN-57-14) (AF 18(600)1109) AD 115046

Unclassified

Also published in Proc. Nat'l. Acad. Sciences, v. 43: 249-252, Feb. 1957.

Using Hilbert space methods, the author states five theorems on Lie groups acting on a differentiable manifold. Proofs are promised in a subsequent publication. Examples of the theorems are:

(1) If y is a compact ν -dimensional group and if X_α ($\alpha = 1, 2, \dots, \nu$) denotes a basis of its algebra, there exists a constant k such that $f \in \mathcal{H}$ (=Hilbert space of square integrable functions) and $\int f d\tau = 0$ imply $\int f^2 k \sum X_\alpha f^2$, where $d\tau$ is the invariant measure.

(2) An element X of the Lie algebra of a Lie group y defines a one-parameter compact subgroup of y if, and only if, there exists a constant k such that every function $f \in \mathcal{H}$, orthogonal to the space $\mathcal{H}' = \{ \phi; \phi \in \mathcal{H}, X\phi = 0 \}$, satisfies $\int f \leq k \|Xf\|$. (Math Rev. abstract)

IAS.05:015

Institute for Advanced Study, Princeton, N. J.

INTEGRATION OF A DIFFERENTIAL FORM ON AN ANALYTIC COMPLEX SUBVARIETY, by P. Lelong. Dec. 1956, 6p. (AFOSR-TN-57-20) (AF 18(600)1109) AD 115054

Unclassified

Also published in Proc. Nat'l. Acad. Sciences, v. 43: 246-248, Feb. 1957.

The purpose of this note is to give a precise definition of the operator of integration

$$t(\omega) = \int_W \omega$$

for an exterior differential form ω on an analytic complex subvariety W . The problem arises because an analytic complex subvariety in a domain D of C^n (or, more briefly, an analytic set in D) is not, in general, a manifold. We give (a) an existence theorem for $t(\omega)$, (b) a proof that t is a closed current in D , that is $t(\phi) = 0$ for the forms with compact support, which are homologous to zero in D . (Contractor's abstract)

IAS.05:016

Institute for Advanced Study, Princeton, N. J.

CONSTRUCTION OF THE ENVELOPES OF HOLOMORPHY OF ARBITRARY DOMAINS, by H. J. Bremermann. Feb. 1957, 31p. incl. refs. (AFOSR-TN-57-49) (AF 18(600)1109) AD 115088

Unclassified

Also published in Rev. Mat. Hisp.-Amer., v. 17: 175-200, 1957.

In the space of several complex variables C^n there is associated with every domain D its "envelope of holomorphy" $E(D)$ which is the largest domain (schlicht or locally schlicht) containing D such that all functions holomorphic in D can be continued holomorphically into $E(D)$. For a given domain D the envelope $E(D)$ thus is defined by "the set of all functions holomorphic in D ." The problem to construct D explicitly for any given domain D is solved completely for the case where both D and $E(D)$ are schlicht. The process can be carried out by a computer. If D or $E(D)$ or both are non-schlicht, then the process is still applicable and it is shown that it gives $E(D)$ if it converges to a pseudo-convex domain. (Contractor's abstract)

IAS.05:017

Institute for Advanced Study, Princeton, N. J.

REPRESENTATIONS AND REPRESENTATIVE FUNCTIONS OF A LIE GROUP, by G. Hochschild and G. D. Mostow. Mar. 1957, 82p. incl. refs. (AFOSR-TN-57-158) (AF 18(600)1109) AD 126450

Unclassified

Also published in Ann. Math., v. 66: 495-542, Nov. 1957.

Let G be a Lie group with a finite number of connected components and let $R(b)$ denote the ring of complex-valued continuous functions on G whose translates are finite dimensional. Investigation is undertaken of (1) the algebraic structure of $R(b)$, (2) the group A of automorphisms of $R(b)$ regarded as G -module, and (3) the relation between G and A . A case of central interest is the one in which $R(b)$ is a finitely generated ring. Under this hypothesis, A turns out to be the "universal complexification" of G . This result can be regarded as a direct generalization of Tannaka's duality theorem for compact Lie groups and Harish-Chandra's analogue for connected semi-simple groups. The hypothesis that

IAS.05:018 - IAS.05:022

$R(b)$ be finitely generated is equivalent to the condition that G modulo the topological closure of the commutator subgroup of the connected component of the identity be compact. Conversely, if A is the universal complexification of G , then $R(b)$ is finitely generated. Thus the class of Lie groups with $R(b)$ finitely generated is the precise class for which Tannaka's duality holds. (Contractor's abstract)

IAS.05:018

Institute for Advanced Study, Princeton, N. J.

[FINITE MODELS IN THE THEORY OF THE POTENTIAL] Modeles finis en theorie du potentiel, by G. Choquet and J. Deny. Apr. 1957, 71p. (AFOSR-TN-57-177) (AF 18(600)1109) AD 126472 Unclassified

Also published in Jour. Analyse Math. (Jerusalem), v. 5: 77-135, 1956/1957.

A definition is given of the theory of the potential, considered as a study of certain defined cores in a locally compact space X , having characteristics analogous to those of the Newtonian core in the Euclidean space. The term "core" is defined and analyzed. A study is made of the symmetrical and degenerate cores. The theorem of duality is discussed and applications are cited.

"plurisubharmonic solution" is closely connected with the envelope of holomorphy of a certain domain and can be computed explicitly. Finally extensions to noncontinuous boundary values, Banach spaces, and Stein manifolds are discussed. The plurisubharmonic solution together with the corresponding plurisuperharmonic solution gives an estimate for the variation of the harmonic solution (of $2n$ real variables) and solutions of similar differential operators under holomorphic transformations. (Contractor's abstract)

IAS.05:020

Institute for Advanced Study, Princeton, N. J.

GENERAL MINIMAX THEOREMS, by M. Sion. Apr. 1957 [10]p. incl. refs. (AFOSR-TN-57-204) (AF 18(600)-1109) AD 126501 Unclassified

Also published in Pacific Jour. Math., v. 8: 171-176, 1958.

The main result in this paper is the following generalization of von Neumann's minimax theorem: Let M, N be compact, convex spaces and f a function on $M \times N$ that is upper semicontinuous and quasi-concave in M and lower semi-continuous and quasi-convex in N ; then

$$\max_{\mu \in M} \min_{\nu \in N} f(\mu, \nu) = \min_{\nu \in N} \max_{\mu \in M} f(\mu, \nu).$$

From this we deduce other general minimax theorems including those of Kneser, Fan, and Nikaido. (Contractor's abstract)

IAS. 05:019

Institute for Advanced Study, Princeton, N. J.

ON A GENERALIZED DIRICHLET PROBLEM FOR PLURISUBHARMONIC FUNCTIONS AND PSEUDO-CONVEX DOMAINS. CHARACTERIZATION OF SLOV BOUNDARIES, by H. J. Bremermann. Apr. 1957, 49p. refs. (AFOSR-TN-57-178) (AF 18(600)1109) AD 126473 Unclassified

Also published in Trans. Amer. Math. Soc., v. 91: 246-276, May 1959.

The Perron-Caratheodory method to find a harmonic function assuming given values on the boundary of a domain is extended from one to several complex variables. The harmonic functions are replaced by the plurisubharmonic functions. The upper envelope of the plurisubharmonic functions smaller than or equal to the given boundary values (where these are prescribed) is a plurisubharmonic function, but it is in contrast to one variable, in general not pluriharmonic, which is a real part of a holomorphic function. It exists for pseudoconvex domains and assumes the (arbitrarily) given boundary values if and only if these are prescribed on the Silov boundary. Its properties are studied and the Silov boundaries are characterized. It is shown that thus

IAS.05:021

Institute for Advanced Study, Princeton, N. J.

FUNCTION RINGS AND RIEMANN SURFACES, by J. Wernier. May 1957, 42p. (AFOSR-TN-57-207) (AF 18(600)1109) AD 126504 Unclassified

Also published in Ann. Math., v. 67: 45-71, Jan. 1958.

The Banach algebra C of all continuous complex valued functions of the unit circle is studied. The closed subalgebras of C which contain the constant 1 and which separate points on the circle are classified as far as possible. Rings of analytic functions on certain Riemann surfaces play a central part in the classification. A restricted class of subalgebras of C is considered. The method used here however can be applied to a much wider class.

IAS.05:022

Institute for Advanced Study, Princeton, N. J.

EXTENSIONS OF REPRESENTATIONS OF THE GROUPS

IAS.05:023 - IAS.05:026

AND LIE ALGEBRAS. I, by G. Hochschild and G. D. Mostow. June 1957, 30p. (AFOSR-TN-57-308) (AF 18(600)1109) AD 132379
Unclassified

Also published in Amer. Jour. Math., v. 79: 924-942, Oct. 1957.

Let K be a group, G a subgroup of K , ρ a representation of G , and V the representation space of ρ . A representation σ of K is an extension of the representation ρ of G if the representation space W of σ contains V as a G -stable subspace and σ coincides with ρ on V . A standard construction is given yielding W for K such that W contains V as a G -stable subspace and is finite dimensional wherever such a representation space exists at all. If K is a connected Lie group, and for the category of finite dimensional continuous representations of K , this gives a complete solution of the extendibility problem. A construction is given which makes it possible to treat the more general case where $K = HG$ with $H \cap G$ compact. Some of the basic results on the existence of faithful representations for connected Lie groups are proved by means of the extension theorem. In particular, the use of Ado's theorem on the existence of a faithful representation for a Lie algebra is completely eliminated. Zassenhaus's extension theorem (Comment. Math. Helv., v. 26: 252-274, 1952) for Lie algebras is proved.

IAS.05:023

Institute for Advanced Study, Princeton, N. J.

RINGS OF ANALYTIC FUNCTIONS, by J. Wermer. July 1957, 24p. (AFOSR-TN-57-421) (AF 18(600)1109) AD 132500
Unclassified

Also published in Ann. Math., v. 67: 497-516, May 1958.

Let E be the open unit disk in the z -plane and let \bar{E} be its closure. Let ϕ be an analytic function on E extendable to all of \bar{E} to be continuous and assume if z_1 and $z_2 \in \bar{E}$, $z_1 \neq z_2$, then $\phi(z_1) \neq \phi(z_2)$. Under this hypothesis, and by a well-known theorem of J. L. Walsh (Amer. Math. Soc. Colloquium Publications, v. 20: 36), every function analytic on E and continuous on \bar{E} is uniformly approximable on \bar{E} by polynomials in ϕ . Previous work by J. Wermer on function rings and Riemann surfaces (Ann. Math., v. 67: 45-71, 1958) is continued to include the analogous approximation problem when the single function ϕ is replaced by a pair of analytic functions ϕ and f , and the disk E is replaced by a finite region on a Riemann surface. The study is restricted to the case when ϕ and f are both analytic on the boundary of the region considered as well as on the region itself.

IAS.05:024

Institute for Advanced Study, Princeton, N. J.

ON THE FUNDAMENTAL GROUP OF A HOMOGENEOUS SPACE, by G. D. Mostow. June 1957 [14]p. incl. refs. (AFOSR-TN-57-371) (AF 18(600)1109) AD 136556
Unclassified

Also published in Ann. Math., v. 66: 249-255, Sept. 1957.

Proof is presented that generally if the fundamental group of a homogeneous space M is solvable, then it is finitely generated and its rank cannot exceed the dimension of M (a homogeneous space is a connected space on which a Lie group operates transitively). The method of proof consists of reducing the problem to the case in which the group acting transitively on the homogeneous space is itself solvable and of applying the results of P. A. Smith (Ann. Math., v. 36: 210-229, 1935) on solvable Lie groups. Smith proved that the rank of the fundamental group F of a group manifold G cannot exceed the dimension of G .

IAS.05:025

Institute for Advanced Study, Princeton, N. J.

ON VECTOR SPACES WITH AN ALTERNATE INNER PRODUCT, by D. S. Ornstein. Nov. 1957, 3p. (AFOSR-TN-57-763) (AF 18(600)1109) AD 136753
Unclassified

Kaplansky has questioned whether every vector space with an alternate inner product is the sum of two subspaces such that the inner product of any two elements in the subspace equals zero. For the case of a vector space with countable dimension, the question has been answered by Kaplansky in the affirmative. The answer is negative when the vector space has uncountable dimension as is shown by the use of a counterexample.

IAS.05:026

Institute for Advanced Study, Princeton, N. J.

[SEMI-LATTICE SETS AND LATTICE SETS OF CONTINUOUS FUNCTIONS] Ensembles semi-réticulés et ensembles réticulés de fonctions continues, by G. Choquet and J. Deny. [1957] [11]p. (AF 18(600)1109)
Unclassified

Published in Jour. Math. Pures Appl., v. 36: 179-189, Apr.-June 1957.

Let X be a topological space, F a family of couples (x, σ) where x is a point of X and σ is a positive Radon measure on X having compact support and vanishing on the point x , and G a family of positive Radon measures on X with compact supports. Let E be the set of all continuous real-valued functions u on X such that

IAS.05:027 - IAS.05:030

$\int_G u d\sigma \leq u(x)$ for every (x, σ) in F and $\int u d\tau \leq 0$ for every τ in G . Then E is a convex cone which is closed in the topology of uniform convergence on compact sets and also is closed under taking the minimum of two functions (i.e., is a lower semi-lattice). The authors' principal result is the converse theorem that any such cone of functions can be characterized by a set of inequalities of the above type. If the cone E is compact around its vertex (i.e., if the functions of E , suitably normalized, form an equi-continuous family), then the compact supports of the above measures can be restricted to finite sets, and the above theorem becomes a direct generalization of the classical Harnack inequalities for positive harmonic functions. (Math. Rev. abstract)

IAS.05:027

Institute for Advanced Study, Princeton, N. J.

[INTEGRATION OVER A COMPLEX ANALYTICAL SET] Intégration sur un ensemble analytique complexe, by P. Lelong. [1957] [24]p. [AF 18(600)1109]

Unclassified

Published in Bull. Soc. Math. de France, v. 85: 239-262, 1957.

An attempt is required in the theory of functions of several variables, to form an exact definition of the integral $\int_A \omega$ stretched over an analytic set A . An obstacle is the fact that analytic sets do not demonstrate points which can be made uniform. The work defines $t(\omega) = \int_A \omega$ and shows that $t(\omega)$ is a closed, positive current of double degree (p,p) when $(p = \dim A)$. The result is gained with the aid of interesting continuity theorems for currents. A particular development is devoted to the surface content of analytical sets.

IAS.05:028

Institute for Advanced Study, Princeton, N. J.

FIXED POINTS AND TORSION ON KÄHLER MANIFOLDS, by T. Frankel. Feb. 1958, 9p. incl. refs. (AFOSR-TN-58-142) (AF 18(600)1109) AD 152169

Unclassified

Also published in Ann. Math., v. 70: 1-8, July 1959.

The structure of the fixed point set F is studied for Kähler manifolds. Bott has given some important results on the homology of certain homogeneous spaces and the loop space to a group. The theorems now established can be considered as direct generalizations and new proofs of Bott's work. An extension of the Morse theory of critical points is given to functions with non-degenerate critical manifolds.

IAS.05:029

Institute for Advanced Study, Princeton, N. J.

THE SPECTRAL THEORY OF BOUNDED FUNCTIONS, by C. S. Herz. Apr. 1958 [90]p. incl. refs. (AFOSR-TN-58-363) (In cooperation with Cornell U., Ithaca, N. Y., under AF 18(600)685) (AF 18(600)1109) AD 154268; PB 134928

Unclassified

Also published in Trans. Amer. Math. Soc., v. 94: 181-232, Feb. 1960.

An exhaustive survey is given of the spectral theory of bounded functions. The exposition is carried out on a locally compact Abelian group. The discussion is divided into 6 parts: the spectrum, the point spectrum, potential theory and spectral analysis, the spectral synthesis problem, representations, and examples of spectral synthesis.

IAS.05:030

Institute for Advanced Study, Princeton, N. J.

SOME GLOBAL PROPERTIES OF CONTACT STRUCTURES, by J. W. Gray. May 1958, 45p. incl. refs. (AFOSR-TN-58-431) (AF 18(600)1109) AD 158235; PB 135154

Unclassified

Also published in Ann. Math., v. 69: 421-450, Mar. 1959.

A problem is investigated for determining if different contact structures exist on a given manifold. A manifold carries a contact structure if the coordinate transformations can be chosen to preserve the 1-form $dz - \sum y^i dx^i$ up to non-zero, multiplicative factor. If the manifold is orientable, then this property is equivalent to the existence of a globally defined 1-form α of maximal rank. Further equivalent conditions are discussed. The existence of the 1-form implies that the structure group of the tangent bundle can be reduced to the unitary group. The manifold is said to be an almost-contact manifold. The obstructions to the existence of such a structure are investigated. Global contact transformations, i.e., transformations which preserve α up to a non-zero, multiplicative factor τ , are discussed. Analysis occurs only in the definitions and the proofs consist of algebraic manipulations. The factors τ which occur in contact transformations are not arbitrary. Results are applied to the study of deformations of contact structures. Appropriate definitions are reviewed and the proof that all deformations are trivial is provided. The property that the strict deformation space consists of the entire appropriate first cohomology group is presented. (ASTIA abstract)

IAS.05:031 - IAS.05:033

IAS.05:031

Institute for Advanced Study, Princeton, N. J.

THE HULL OF A CURVE IN C^n , by J. Wermer. [1958]
[12]p. (AF 18(600)1109) Unclassified

Published in Ann. Math., v. 68: 550-561, Nov. 1958.

If S is a compact subset of C^n , the space of n complex variables, its hull $h(S)$ is defined to be the set of all x in C^n with the following property: to every polynomial P in n variables there corresponds a point y in S such that $|P(x)| \leq |P(y)|$. Then $h(S)$ is compact (it is the maximal ideal space of the algebra which is the uniform closure of the polynomials on S) and contains S . The author studies the nature of $h(S)$ when S is an arc or a simple closed curve, with the aid of his recent work on function algebras [Ann. Math., v. 67: 45-71; 497-516. See also item nos. IAS.05:021; IAS.05:023]. If y_1, \dots, y_n are analytic functions in a disc $D: |\lambda| < r$ and if the map $\lambda \rightarrow Y(\lambda) = (y_1(\lambda), \dots, y_n(\lambda))$ is a homeomorphism of D , then the set $Y(D)$ is said to be an element through the point $Y(0)$. A set Σ in C^n is an analytic surface if each point p on Σ , except perhaps for points in a discrete subset Σ_0 (called multiple points), has a neighborhood U in C^n such that $U \cap \Sigma$ is an element through p , while each p in Σ_0 has a neighborhood U in C^n such that $U \cap \Sigma$ is the union of a finite set of elements through p . Suppose now that ϕ_1, \dots, ϕ_n are analytic functions on the unit circle T which together separate points on T and suppose that the derivative of ϕ_1 has no zero on T . Let Γ be the simple closed curve consisting of the points

$$(\phi_1(u), \dots, \phi_n(u)) \quad (|u| = 1).$$

Theorem: Under these conditions, either $h(\Gamma) = \Gamma$, or $h(\Gamma) - \Gamma$ is an analytic surface with at most finitely many multiple points; the second alternative occurs if and only if

$$\int_{|u|=1} P(\phi_1(u), \dots, \phi_n(u)) \phi_1'(u) du = 0$$

for every polynomial P in n variables. Next, suppose that ϕ_1, \dots, ϕ_n are analytic functions on the unit interval I which together separate points on I , and suppose that the derivative of ϕ_1 has no zero on I . Let L be the arc consisting of the points $(\phi_1(t), \dots, \phi_n(t))$ ($0 \leq t \leq 1$).

Theorem: Under these conditions, $h(L) = L$; in fact, every continuous function on L is the uniform limit of polynomials on L . These theorems are complemented by the following examples: (a) It was previously known that there are arcs in C^n ($n \geq 2$) whose hulls are at least 2-dimensional; (b) the author now shows that there is

a simple closed curve in C^6 whose hull is at least 4-dimensional (it contains the cartesian product of two spheres). Thus, the analyticity of the parametrizations cannot be dropped from the hypotheses of the above theorems, although the possibility is open that it can be replaced by a weaker assumption. (Math. Rev. abstract)

IAS.05:032

[Institute for Advanced Study, Princeton, N.J.]

[THE CHARACTERIZATION OF RUNGE AREAS BY PLURISUBHARMONIC FUNCTIONS] Die Charakterisierung Rungescher Gebiete durch pluri-subharmonische Funktionen, by H. J. Bremermann. [1958] [14]p. Incl. refs. (AF 18(600)1109) Unclassified

Published in Math. Ann., v. 136: 173-186, 1958.

A pair (D, D') of domains of holomorphy in C^n is called a Runge pair if D is contained in D' and if the set of all holomorphic functions on D' is dense in the set of all holomorphic functions on D , equipped with the topology of compact convergence. The main result of this paper is: (D, D') is a Runge pair if and only if $D = \lim D_k$.

$D_1 \subseteq D_2 \subseteq \dots \subseteq D$, where $D_k = \{z: V_k(z) < 0\}$ and $V_k(z)$ is plurisubharmonic in D' . $W(z)$ is called plurisubharmonic in D' if for every relatively compact subset D_0 of D' there is a sequence W_1, W_2, \dots of C^∞ -functions on D_0

such that $W_1(z) \geq \dots \geq W(z)$, $W(z) = \lim W_k(z)$, and

$$\sum_{j=1}^n \frac{\partial^2 W_k(z)}{\partial z_j \partial \bar{z}_j} dz_1 d\bar{z}_j$$

is positive semidefinite. Consequences: (i) If (D, D') is a Runge pair and E a (1-dimensional) complex line, then $D \cap E$ is relatively simply connected with respect to $D' \cap E$. (ii) If D is a domain of holomorphy which is convex (in the usual sense), then (D, C^n) is a Runge pair. (iii) Let $D = \{z: V(z) < 0\}$ where $V(z)$ is plurisubharmonic in some neighborhood of \bar{D} ; then the Banach algebra of all continuous functions on \bar{D} which are holomorphic in D is dense in the algebra of all holomorphic functions on D , equipped with the topology of uniform convergence. (Math. Rev. abstract)

IAS.05:033

Institute for Advanced Study, Princeton, N. J.

[DIRICHLET SPACES. 1. THE ELEMENTARY CASE] Espaces de Dirichlet. I. Le cas élémentaire, by A. Beurling and J. Deny. [1958] [22]p. (AF 18(600)1109) Unclassified

Published in Acta Math., v. 99: 203-224, 1958.

IAS. 05:034; IAS. 10:001-003;
IAS. 11:001

An introduction is given for a class of function spaces, for which a potential theory without a "nucleus" is developed. Linear transformations ("contractions") $T(z)$ in the complex plane C are of importance for any two numbers z_1 and z_2 in reducing the separation:

$$|T(z_1) - T(z_2)| \leq |z_1 - z_2| \text{ and are called normal, if the}$$

point O remains fixed. Basic characteristics of Dirichlet spaces are defined. A space X of n points x_i ($i = 1, 2, \dots, n$)

is studied. \mathcal{C} is the vector space of all complex valued functions u on X and Hermite forms $H(u)$ are used to develop a Hilbert space, which can be ordered to a function $\Delta(x, y)$ defined upon $X \times X$, with the aid of which a generalized Laplace operator is formed. If for every normal contraction $T(u): H(T(u)) \leq H(u)$, then $H(u)$ is called a

Dirichlet form. If $H(u)$ is positive definite, then $H(u)$ is a Dirichlet norm and \mathcal{C} , provided with this structure, is a Dirichlet space. Numerous potential theoretical characteristics are given for these Dirichlet forms, respective spaces. A theory for the Dirichlet problem is developed. Three instructive examples from electrodynamics, electrostatics and the theory of conformal mapping are given.

IAS.05:034

Institute for Advanced Study, Princeton, N. J.

[ON THE NATURE OF SOME COMPLEX ANALYTICAL ENSEMBLES] Sur l'aire des ensembles analytiques complexes, by P. Lelong. [1958] [AF 18(600)1109]

Unclassified

Published in Ann. Acad. Scient. Fenn., Series A. I., No. 250/21, 1958, 10p.

Further results are announced upon positive currents and the surface contents of analytical sets. The positive distribution forms $\Theta = i \sum_{p,q} \epsilon_{pq} - dz_p \wedge dz_q$, con-

sidered in the complex number space C^n , have a limited growth in a more exactly defined sense. A plurisubharmonic function V is constructed through an integral, so that one has $\partial \bar{\partial} V = \Theta$. A decrease of the growth is indicated for V . A construction of holomorphic functions for previously given zero position

areas $A \subset C^n$ results as a special case. The author states the consequent result varies somewhat from the older Kneser theorem.

IAS.10:001

Institute for Advanced Study, Princeton, N. J.

SEMINARS ON ANALYTIC FUNCTIONS, VOL. 1, Inst. for Advanced Study, Princeton, N. J. (Sept. 2-14, 1957). [1957] 346p. incl. refs. (AFOSR-TN-58-750, v. 1) (AF 18(603)118) AD 205641; PB 143754

Unclassified

This volume contains the short addresses delivered at 2 of the seminars of the Conference on Analytic Functions. Seminar I on the theory of functions of several complex variables includes 17 speeches. Seminar II on conformal mapping and Schlicht functions includes 8 speeches.

IAS.10:002

Institute for Advanced Study, Princeton, N. J.

SEMINARS ON ANALYTIC FUNCTIONS, VOL. II, Inst. for Advanced Study, Princeton, N. J. (Sept. 2-14, 1957). [1957] 320p. incl. refs. (AFOSR-TN-58-750, v. 2) (AF 18(603)118) AD 205642; PB 143755

Unclassified

This volume contains the short addresses given at 3 seminars of the Conference on Analytic Functions. Seminar III includes 7 speeches concerning some aspects of Riemann surfaces. Seminar IV on the theory of automorphic functions contains 6 speeches. Seminar V consists of 13 speeches on phases of the topic analytic functions as related to Banach algebras.

IAS.10:003

Institute for Advanced Study, Princeton, N. J.

ANALYTIC FUNCTIONS; a Conference, Inst. for Advanced Study, Princeton, N. J. (Sept. 2-14, 1957), ed. by M. Morse and A. W. Tucker. Princeton, Princeton U. Press, 1960, 197p. incl. diagrs. table, refs. (AFOSR-TN-58-750A) (AF 18(603)118) AD 233343

Unclassified

This book contains the 8 principal addresses delivered at the conference. The subjects dealt with are: (1) differential mappings, (2) non-compact complex spaces, (3) complex analytic structure of the space of closed Riemann surfaces, (4) perturbation of structure, (5) quasiconformal mappings and Teichmüller's theorem, (6) compact analytic surfaces, (7) conformal mapping of Riemann surfaces, and (8) coefficients of univalent functions.

IAS.11:001

Institute for Advanced Study, Princeton, N. J.

ON A CONJECTURE OF H. HADWIGER, by B. Grünbaum. Nov. 1958, 7p. (AFOSR-TN-58-1055) (AF 49(638)253) AD 206983

Unclassified

Also published in Pacific Jour. Math., v. 11: 215-219, 1961.

For any compact convex set with interior points K in the Euclidean plane E^2 , $i(K)$ is taken as the greatest

INS.02:001; IQS.01:001;
INT.02:001; INT.01:005

natural number with the following property: there are translates K_n , $1 \leq n \leq i(K)$, of K such that $K \cap K_n \neq \emptyset$ for all n ; $\text{Int } K_n \cap \text{Int } K_m = \emptyset$ for $n \neq m$. It is known that $7 \leq i(K) \leq 9$ for any $K \subseteq E^2$, and that the bounds are obtained ($i(K) = 7$ if K is a circle, $i(K) = 9$ if K is a parallelogram). A conjecture by Hadwiger is established in the following theorem: If K is not a parallelogram, then $i(K) = 7$. Moreover, if 7 translates of K satisfy the above conditions, then one of them coincides with K . The proof using centrally symmetric convex sets, and applications are presented.

INS.02:001

Institute of the Aeronautical Sciences, Inc., New York.

REVIEW AND ANALYSIS OF AERONAUTICAL RESEARCH INFORMATION, by S. P. Johnston and others. Jan. 1957-Dec. 1958. (AF 49(638)185)
Unclassified

Contract funds maintain the preparation of technical aeronautical abstracts, approximately 50% of which are from foreign literature. The abstracts are disseminated monthly under the title International Aeronautical Abstracts, a special section of Aeronautical Engineering Review which became Aero/Space Engineering in 1958. The abstracts are distributed to the European scientific community as a separate publication entitled IAS Abstracts. They cover the following scientific fields: acoustics (sound and noise); aerodynamics and fluid mechanics (including aerothermodynamics, boundary layer, flow of fluids, internal flow, jet flaps and wings, stability and control, and wings and airfoils); aeroelasticity; electronics; fuels and lubricants; instruments; missiles and rockets; nuclear energy; power plants (including jet, turbine, ram-jet, pulse-jet and rocket); propellers; research and research facilities; rotating wing aircraft; space travel; structures (including beams and columns, cylinders and shells, sandwich construction and thermal stress), and thermodynamics.

IQS.01:001

Instituto de Quimica Fisica, Madrid (Spain).

KINETICS OF THE SULPHURATION OF METALLIC SURFACES, by J. Llopis, J. M. Gamboa, and L. Arizmendi. Annual rept. no. 1. May 1958, 52p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-639) (AF 61(514)1329) AD 162170; PB 136887
Unclassified

Radioactive S isotopes were used to follow the kinetics of the sulfuration processes. Metallic disks were introduced into the reacting solutions and moved in simultaneous translation and rotation by a small motor running at 60 rpm. The amount of deposited S can be calcu-

lated from the measurements of radioactivity on the surfaces of the disks. Aqueous solutions of thiourea labelled with S^{35} and C^{14} were reacted with Cu and Pt and the kinetics of the reaction were followed at varying times of contact of the reacting phases. The chemical reaction took place at the surface of Cu, forming a film of CuS. The kinetics of the reaction can be represented

by the equation: $\frac{\Delta^2}{k_d} + \frac{\Delta}{k_r} = t$, where Δ is the deposit

formed per unit area. This expression contains the quadratic law, governed by k_d , and the law for reactions on interfaces, governed by k_r . Reaction with Pt finishes

with only a few layers of molecular thicknesses. The kinetics of this surface reaction can be accounted for either by a chemisorption of S on the surface of the Pt or by the formation of very thin layers in accordance with Mott's theory. Surface reaction experiments on Cu were conducted with solutions of sodium polysulfide

labelled with S^{35} . Results showed that at temperatures from 25° to 60°C the form of the curves representing the amount of S deposited against time corresponds to the above equation and that the reaction rate increases with temperature. For temperatures from 17° to -0.5°C a change in the kinetic law was noted because the film was porous and the corrosion was greater. The reaction of Cu and S dissolved in C_6H_6 followed a linear kinetic law. (ASTIA abstract)

INT.02:001

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

AEROTHERMOCHEMISTRY, by G. Millan. Jan. 1958, 1v. incl. diagrs. tables, refs. (AFOSR-TR-58-27) (AF 61(514)441; continued by AF 61(514)997) AD 152202
Unclassified

A few chapters of this report are based on lectures given by von Karman to acquaint aeronautical engineers with the phenomenon of combustion occurring in flowing media. A systematic treatment is presented for the thermodynamics of gas mixtures, the theory of chemical equilibrium, the elements of chemical kinetics, and the theory of transfer phenomena in gases and gas mixtures. Analyses are made of problems in flame stabilization, combustion of liquid droplets, and diffusion flames.

INT.01:005

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

THE COMBUSTION OF DROPLETS. INFLUENCE OF FORCED CONVECTION, by C. S. Tarifa and G. Millan.

INT.01:006, 007; INT.03:001, 002

Dec. 20, 1956 [58]p. incl. diagrs. tables. (AFOSR-TN-57-303) (AF 61(514)734-C) AD 132374 Unclassified

The description of the experimental installations is followed by the results of the research program carried out at the Combustion Laboratory of the INTA in order to determine the influence of forced convection on the characteristics of the combustion of fuel droplets suspended from quartz filaments in an air stream. The following fuels were tested: benzene, toluene, n-heptane, ethyl and methyl alcohols. Results confirmed Spalding's findings on the existence of envelope combustion and wake combustion. The zone where each type of combustion takes place as well as that where both occur indistinctly, are determined. Results also suggest the applicability of Frössling's law to the study of the activation of combustion due to forced convection, at least for large Reynolds numbers. As an application of these results an appendix is concluded giving a computation of the reduction in the life-time of a droplet shot through a still atmosphere at a given initial velocity, as a consequence of convection effects. It is concluded that this reduction depends essentially on the initial Reynolds number of motion and, to a minor extent, on the Schmidt number of the fuel vapours and air.

INT.01:006

Instituto Nacional de Técnica Aeronáutica, Esteban Terradas, Madrid (Spain).

ANALYSIS OF THE COMBUSTION PROCESSES IN GAS TURBINES, by G. Millán and S. Sanz. Oct. 8, 1956, 26p. incl. diagrs. refs. (AFOSR-TN-57-801) (AF 61(514)-734-C) AD 154209 Unclassified

Presented at Fourth International Congress on Combustion Engines, Zürich, 1957.

Analysis is made of the problem of the combustion of liquid fuels, specially applied to those normally used in gas turbines. Prior consideration is given to the problem of the combustion of single droplets, including the theoretical study of the process as well as an experimental verification of the results through the data obtained from the research work carried out at the Combustion Laboratory here. The effect of free and forced convection under the preceding conditions are studied both theoretically and experimentally using the results obtained at this laboratory. Experimental study is made on the interaction effect of droplets as a preliminary step for a generalization of the method to more complex systems. Graphical information is included for the determination of the times of combustion under the preceding conditions. Consideration is given to the problems of the combustion of sprays including an analysis of the possibilities of generalizing the results obtained above with the purpose of determining the combustion efficiency for more practical cases as well as other characteristic parameters of the process. An extensive

bibliography on each subject is included. (Contractor's abstract, modified)

INT.01:007

Instituto Nacional de Técnica Aeronáutica Esteban Terradas, Madrid (Spain).

COMBUSTION OF FUEL DROPS: FORCED CONVECTION AND INTERACTION EFFECTS, by G. Millán and C. S. Tarifa. Sept. 20, 1956 [39]p. incl. diagrs. refs. (AFOSR-TN-57-802) (AF 61(514)734-C) AD 154210 Unclassified

Presented at Second European Aeronautical Congress, Scheveningen (Netherlands) Sept. 25-29, 1956.

This previously appeared as item no. INT.01:004 and was subsequently assigned the control number, AFOSR-TN-57-802.

INT.03:001

Instituto Nacional de Técnica Aeronáutica Esteban Terradas, Madrid (Spain).

CALCULATION OF THE PROPAGATION VELOCITY OF A PLANE LAMINAR FLAME, by J. M. de Sendagorta. June 8, 1957, 18p. (AFOSR-TN-57-668) (AF 61(514)997; continuation of AF 61(514)441) AD 136657; PB 135587 Unclassified

A method of calculation is proposed which is applicable to flames with chemical reactions whose advancement is determined by the products concentration and whose molecularity is of first or second order, and where the Lewis-Semenov number may differ from unity. (Contractor's abstract)

INT.03:002

Instituto Nacional de Técnica Aeronáutica Esteban Terradas, Madrid (Spain).

COMPARISON OF ANALYTICAL METHODS FOR THE CALCULATION OF LAMINAR FLAME VELOCITY, by G. Millán, J. M. de Sendagorta, and I. Da Riva. Aug. 25, 1957 [68]p. incl. diagrs. tables. (AFOSR-TN-57-669) (AF 61(514)997) AD 136658 Unclassified

A calculation is presented of the flame's velocity for a set of typical cases. For each case, the analytical methods of Y. B. Zeldovich and others (NACA Tech. Memo. no. 1084), Boys-Corner (Proc. Royal Soc. (London), A, v. 198: 388, 1949), Th. von Karman and S. S. Penner (Selected Combustion Problems AGARD, 1953), and K. A. Wilde (Jour. Chem. Phys., v. 22: 1788, 1954) are applied. The values obtained with each method are compared to the

INT.03:003 - INT.03:007

exact values resulting from the numerical integration of the flame's equations. (Contractor's abstract)

INT.03:003

Instituto Nacional de Técnica Aeronautica Esteban Terradas, Madrid (Spain).

HYDRAZINE DECOMPOSITION FLAME, by G. Millán and J. M. de Sendagorta. Aug. 30, 1957 [17]p. incl. diagr. (AFOSR-TN-57-670) (AF 61(514)997) AD 136659
Unclassified

The complete kinetic model of G. K. Adams and G. W. Stocks (Fourth Symposium on Combustion, Boston, 1952) is applied to calculate the propagation velocity of the laminar decomposition flame of hydrazine vapors. The results give an acceptable approximation to the flame velocity when they are compared to experimental values. The over-all reaction rate corresponding to the complete model is similar to that obtained with a simplified kinetic model when, for both cases, the radical concentration is determined under the steady-state assumption. (Contractor's abstract)

INT.03:004

Instituto Nacional de Técnica Aeronautica Esteban Terradas, Madrid (Spain).

COMBUSTION OF MONOPROPELLANT DROPLETS. PART I. A THEORETICAL MODEL OF THE COMBUSTION OF A DROPLET, by C. S. Tarifa and J. M. Salas Larrazabal. July 27, 1957 [49]p. incl. diagrs. table. (AFOSR-TN-57-671) (AF 61(514)997) AD 136660
Unclassified

The present work is a theoretical study of the combustion of a single droplet of liquid monopropellant in an inert atmosphere taking into consideration the diffusion phenomena and the chemical kinetics of the process. This first part of the study contains the integration of the differential equations of the process performed through an approximate analytical method. The validity of this method is checked by comparing its results with those obtained through a numerical integration of the system. Formulas are obtained from which the laws of variation of the magnitudes characteristic of the process can be deduced such as combustion velocity, distance of the flame front to the droplet, maximum temperature, etc., as a function of the droplet radius and of the different parameters, i.e., activation energy and temperature at the infinite. (Contractor's abstract)

INT.03:005

Instituto Nacional de Técnica Aeronautica Esteban Terradas, Madrid (Spain).

COMPARISON OF ANALYTICAL METHODS FOR THE CALCULATION OF LAMINAR FLAME VELOCITY, by G. Millán and I. Da Riva. June 1958 [20]p. incl. diagrs. table. (AFOSR-TN-58-770) (AF 61(514)997) AD 201867; PB 136875
Unclassified

An extension is presented of the comparison between analytical methods for the calculation of the velocity of laminar flames to the case of second-order reaction, and where the ratio of diffusion coefficient to thermal diffusivity of the mixture is different from unity. The values resulting from the application of such methods to some typical cases are compared with those derived from an extension of Karman's method and with the values obtained through a numerical integration of the flame equations. The paper is divided into two parts. Part I establishes the flame equations through the usual application of the following simplifications: the molecular weight and specific heat of the mixture are constant, and thermal conductivity is independent from the composition but it varies linearly with temperature. Part II is devoted to a study of the methods under consideration by applying them to a short number of particular cases.

INT.03:006

Instituto Nacional de Técnica Aeronautica Esteban Terradas, Madrid (Spain).

PREDICTION OF THE PROPAGATION VELOCITY OF LAMINAR FLAME SUPPORTED BY A SECOND-ORDER REACTION, by J. M. de Sendagorta. Apr. 1958 [10]p. incl. diagr. (AFOSR-TN-58-812) (AF 61(514)997) AD 202357; PB 136840
Unclassified

An extension is presented of a previous work in which an analytical method for the computation of the propagation velocity of laminar flames was reported. It deals with an alternative of the method proposed for the case where the flame is supported by a second-order reaction and the Lewis-Semenov Number differs from unity.

INT.03:007

Instituto Nacional de Técnica Aeronautica Esteban Terradas, Madrid (Spain).

COMBUSTION OF MONOPROPELLANT DROPLETS, by C. S. Tarifa and P. Pérez del Notario. [1958] [40]p. incl. diagrs. tables. (AFOSR-TN-58-1038) (AF 61(514)997) AD 206477
Unclassified

Also published in Proc. Third European Aeronautical Congress, Brussels (Belgium) (Sept. 22-27, 1958), v. 2. 635-652, 1958.

A simplified model is proposed for the combustion of monopropellant droplets. The solution of the problem lies on the integration of a non-linear system of three differential equations, where the burning rate is given as

IOW.03:001; IOW.04:001, 002;
IEN.01:001

an eigenvalue of the system. The integration is performed through an approximate analytical method. Results are compared to those obtained through numerical integrations of the system for first and second order chemical kinetics. Dimensionless results are shown and discussed, and some of them are compared to those obtained by experiments. A practical application is performed for hydrazine. (Contractor's abstract)

IOW.03:001

Iowa State Coll., Ames.

ON STABILITY IN THE LARGE FOR PERIODIC SOLUTIONS OF DIFFERENTIAL SYSTEMS, by G. Seifert. Mar. 18, 1957, 9p. (AFOSR-TN-57-88) (AF 18(603)51) AD 120436 Unclassified

Also published in Ann. Math., v. 67: 83-89, Jan. 1958.

The author considers the equation (1) $\dot{x} = f(x, t)$, where x is a real two-dimensional vector and f is periodic in t . The bounded, simply-connected region R in the (x_1, x_2) plane is called a relative bound for (1) if it is the closure of a domain, and if, for arbitrary t_0 , every solution $x(t)$ such that $x(t_0) \in R$ remains in R for $t > t_0$. The existence

of a periodic solution of (1) is implied by the existence of a relative bound, and the author gives additional conditions (too lengthy to be presented here) which insure its uniqueness. The method is the consideration of the boundary of R , defined parametrically by $x = z(u)$, $0 \leq u \leq 2\pi$. Let $x(t, u)$ be the solution of (1) such that $x(t_0, u) = z(u)$ and let $\Gamma_{t_0}(u)$ denote the simple closed

curve defined for $t \leq t_0$ by the points $x(t, u)$, $0 \leq u \leq 2\pi$.

Under the conditions given, it is shown that the length of $\Gamma_{t_0}(t)$ tends to zero as $t \rightarrow \infty$, thus implying the uniqueness

of the periodic solution. The result is applied to a system equivalent to the equation $\ddot{x} + f(x)\dot{x} = g(x) + p(t)$. (Math. Rev. abstract)

IOW.04:001

Iowa State Coll. Statistical Lab., Ames.

A GENERALIZED CLASS OF CONTAGIOUS DISTRIBUTIONS, by J. Gurland. [1958] [21]p. incl. tables, refs. (Reprint series no. 49) (AFOSR-TN-58-10) (AF 49-638) (13) AD 148049 Unclassified

Also published in Biometrics, v. 14: 229-249, June 1958.

By appealing to the notions of compound and generalized distributions various classes of contagious distributions are obtained. One of these classes includes as a subclass the family of distributions considered by Beall

and Rescia. Properties of the confluent hypergeometric function are utilized in establishing recurrence relations of the probabilities. Some limiting cases are discussed; in particular it is pointed out the limiting case $\beta = \infty$ of Beall and Rescia is a Polya-Aeppli distribution with a consequent simplification of the computation of probabilities. The question of estimation of parameters in multiparametric families of contagious distributions will be considered in a later paper.

IOW.04:002

Iowa State Coll. [Statistical Lab.] Ames.

TESTING EQUALITY OF MEANS WHEN VARIANCES MAY DIFFER, by J. Gurland and L. Rosenberg. [1958] 37p. incl. tables, refs. (AFOSR-TN-58-1009) (AF 49-638) (43) AD 206152; PB 142599 Unclassified

A finite series representation of the distribution of statistics with a structure similar to that of the t statistic is utilized in obtaining under simple restrictions the exact size of a test when variance heterogeneity is present. Further modification of the technique is utilized for obtaining the exact power of the tests. A method of extending the techniques to the case of more than 2 variables is also considered. (Contractor's abstract)

Israel Inst. of Tech., Haifa. see Technion-Israel Inst. of Tech., Haifa.

IEN.01:001

Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

EFFECT OF NEUTRON BOMBARDMENT ON THE MAGNETIC PROPERTIES OF IRON, by G. Biorci, G. Bonfiglioli and others. Sept. 1958 [49]p. incl. illus. diagrs. tables, refs. (Technical note no. 1b) (AFOSR-TN-58-1096) (AF 61(514)1331) AD 207597; PB 138781 Unclassified

Several specimens of commercial iron have been irradiated with a 1 mev neutron flux of $10^{18}/\text{cm}^2$. Comparison of magnetic properties before and after irradiation shows that the coercive force, the area of the hysteresis loop and the initial permeability have not changed appreciably, and that the remanence and maximum permeability have decreased by about 10%. Since the magnetization curves and hysteresis loops are sensitive to defects having size at least of the order of the Bloch wall thickness (1000A in Fe), their variations are interesting in investigating the possible presence of large defects produced by irradiation. Magnetic measurements seem to be more sensitive to such defects than x-rays methods. The results on magnetic properties confirm that the internal strains produced by

IEN.01:002, 003; IEN.02:001, 002

the radiation are so small that only a negligible contribution is made to the variation of the mechanical properties and that the analogy between radiation damage and cold working is very poor. It is concluded that the increase in strength of irradiated metals is mainly due to some mechanism of anchoring of the dislocations by the point defects produced during the irradiation itself.

IEN.01:002

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

INSTABILITY OF THE BLOCH WALLS DUE TO INTERSTITIAL ATOMS IN A FERROMAGNETIC LATTICE, by G. Biorci, A. Ferro, and G. Montalenti. Final rept. Mar. 1958 [40]p. incl. diagrs. tables, refs. (Technical rept. no. 1c) (AFOSR-TR-58-61) (AF 61(514)1331) AD 158204; PB 135389 Unclassified

The possibility of experimentally verifying Néel's theory of the diffusion viscosity has been studied. It turns out that the theory is quantitatively valid only at conveniently low field strength. In fact, above a critical field, the Bloch walls find an instability position. The role of the instability is essential to explain the viscosity field curves experimentally observed.

IEN.01:003

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

MAGNETIC RELAXATION AT HIGH TEMPERATURE DUE TO GRAIN BOUNDARY SLIP AND TO DISLOCATIONS, by G. Biorci, A. Ferro, and G. Montalenti. Mar. 1958, 1v. incl. illus. diagrs. tables, refs. (Technical note no. 1a) (AFOSR-TR-58-68) (AF 61(514)1331) AD 158275 Unclassified

Also published in Proc. Internat'l. Conf. on Solid State Physics in Electronics and Telecommunications, Brussels (Belgium) (June 2-7, 1958), N. Y., Academic Press, v. 3 (Part I): 235-244, 1960.

The internal mechanical friction and the magnetic relaxation (the relative decrease of initial permeability after demagnetization) as a function of temperature were experimentally determined on specimens of iron of different origin. Both polycrystals and very large (10 to 30 sq cm x 0.05 cm) single crystals were examined. The elastic and magnetic relaxations of single crystals differed among the various types of iron; the magnetic relaxation showed all the characteristics of the diffusion viscosity, but the nature of what diffuses (impurities, dislocations, or other defects) was not determined. The magnetic relaxation in all the polycrystalline specimens was maximum (about 4%) at about 450°C. It corresponded to the internal friction

peak usually attributed to grain boundary relaxation, and has characteristics different from those of the diffusion viscosity. A theoretical interpretation, which is in agreement with experimental results, is given to account for a viscosity effect of this type present in all polycrystalline ferro-magnetic materials at a suitable temperature provided the magnetostriction is not zero and there are 90° Bloch walls.

IEN.02:001

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

ELECTRON MICROSCOPY STUDY OF SURFACE STRUCTURES IN HIGH PURITY (99.996) Al AND IN Al/4% Cu ALLOY. PART I, by G. Bonfiglioli, A. Ferro, and A. Mojoni. [1958] [16]p. incl. illus. (Technical note no. 1c) (AFOSR-TN-56-47) (AF 61(514)1333) AD 148087 Unclassified

The present work is concerned with the surface structures (Sst) observed on electron microscope replicas of electropolished Al and Al/4% Cu. The results reported in the literature on the subject are reviewed and discussed together with some results by the writers. At the present state of knowledge, it is not possible to establish that the Sst represent the true subgrain structure of the metal, since it is certain that their aspect is at least partially controlled by the electropolishing conditions. However, it seems very probable that the Sst bear some relation with the crystal perfection, and possibly with a non-random distribution of impurity (Cu) atoms. Some further experiments are proposed, to clarify at which extent, keeping the polishing conditions constant, the true subgrain structure of the metal is related to the Sst pattern. (Contractor's abstract)

IEN.02:002

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

THERMOLUMINESCENCE AND F-CENTERS, PART I, by G. Bonfiglioli, P. Brovetto, and C. Cortese. [12]p. incl. refs. (Technical note no. 1b) (AFOSR-TN-58-355) (AF 61(514)1333) AD 154260 Unclassified

Also published in Phys. Rev., v. 114: 951-955, May 15, 1959.

Current theories used to explain the experimental results of thermoluminescence from x-ray irradiated NaCl crystals have been found inconsistent. A model has been proposed in which F-centers are the only traps present and some capture centers, probably V-centers, are responsible for depopulating the conduction band of the electrons raised from the F-centers. Various probabilities are associated with the different recombination

IEN.02:003 - IEN.02:007

centers, so that as a recombination level becomes saturated with electrons from the conduction band, another level begins to fill, even though its probability of doing so is less than the first level. In this way the problem inherent in the first-order process explanation of the multiple peaks in the glow curves can be explained without the introduction of multiple types of traps.

IEN.02:003

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

THERMOLUMINESCENCE AND F-CENTERS, PART II, by G. Bonfiglioli, P. Brovetto, and C. Cortese. [1958] [14]p. incl. illus. diags. (Technical note no. 2b) (AFOSR-TN-58-356) (AF 61(514)1333) AD 154261
Unclassified

Also published in Phys. Rev., v. 114: 956-960, May 15, 1959.

Thermoluminescence experiments were conducted on NaCl powders or single crystals which had been irradiated with X-, β -, and γ -rays at room temperature to create F-centers. Specimens of varying degrees of purity were used. Five distinguishable peaks seemed to be resolved although they were not always present together in the same thermoluminescence curve. The temperature of the maximum fluctuated slightly at random from one specimen to another. Further theoretical investigations on the effects of the rate of heating of the crystal and the initial concentration of F-centers are necessary to allow an interpretation of the results.

IEN.02:004

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

THERMOLUMINESCENCE AND F-CENTERS, PART III, by G. Bonfiglioli, P. Brovetto, and C. Cortese. [1958] [13]p. incl. diags. (Technical note no. 3b) (AFOSR-TN-58-357) (AF 61(514)1333) AD 154262
Unclassified

The theoretical calculations begun in part I (item no. IEN.02:002) have been extended. A linear rate of temperature rise and a second order rate process have been assumed. These equations have been integrated to yield expressions for the excitation energy, the probabilities of electron capture for the various luminophor levels, and the initial F-center concentration in terms of data obtainable from the glow curves. An energy level scheme for the F- and V-centers is given.

IEN.02:005

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

FURTHER EXPERIMENTS ON MODULATION OF CONDUCTIVITY BY SURFACE CHARGES IN METALS, by G. Bonfiglioli and R. Maivano. [1958] [12]p. incl. diags. table. (Technical note no. 1a) (AFOSR-TN-58-746) (AF 61(514)1333) AD 201512
Unclassified

A continuation of a previous paper (Phys. Rev., v. 101: 1281, 1956) is presented. An investigation of modulation of conductivity by surface charges in metals as a function of temperature has shown the existence of trapping states at the metal-dielectric interface, with a trap depth of the order of 0.1 to 0.2 ev. A new interpretation of the size effect of resistivity is advanced.

IEN.02:006

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

ON F AND V CENTERS THERMOLUMINESCENT RECOMBINATION, by G. Bonfiglioli, P. Brovetto, and C. Cortese. [1958] 4p. incl. table. (AFOSR-TN-58-751) (AF 61(514)1333) AD 201503
Unclassified

Also published in Phys. Rev. Letters, v.1: 94-95, Aug. 1, 1958.

A second order process is found necessary to interpret the results of thermoluminescence experiments on x-ray irradiated NaCl crystals. A unique excitation energy is found for all the peaks of the glow curve and each of the peaks is associated with a different wavelength. The temperatures of the maxima of the glow curve peaks are not found to be characteristic of the trap depth but rather characteristic of the initial F-center concentration. The recombination centers have been associated with various order V-centers.

IEN.02:007

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

ELECTRON MICROSCOPY STUDY OF SURFACE STRUCTURES IN HIGH PURITY Al AND IN Al/4% Cu ALLOY. PART II (FINAL), by G. Bonfiglioli, A. Ferro, and A. Mojoni. [1958] [26]p. incl. illus. (Technical note no. 2c) (AFOSR-TN-58-1091) (AF 61(514)1333) AD 207588
Unclassified

Electron microscopy was used to study the relationship between the surface substructure of Al and Al/4% Cu alloy as controlled by the degree of aging and the surface substructure which appear in replicas of electropolished specimens. The observations indicated that

IEN. 02:008; IST. 01:014-016

the surface substructure pattern is formed because of a selective oxidation which takes place when electro-polishing is conducted under proper conditions. The surface substructure in pure Al fails to give a direct picture of the actual substructure of the metal. In case of the Al/Cu alloy, however, there is a dependence upon the distribution of Cu atoms, which is particularly noticeable when Cu-rich phase precipitates begin to appear.

IEN.02:008

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

THERMOLUMINESCENCE AND F CENTERS, by G. Bonfiglioli, P. Brovotto, and C. Cortese. Final rept. on Research b. Sept. 1958 [31]p. incl. diagrs. tables. (AFOSR-TR-58-134) (AF 61(514)1333) AD 204428
Unclassified

When an irradiated NaCl crystal is heated according to $T = T_0 + \beta t$, where T_0 is the initial crystal temperature, the crystal emits many peaks of light successively. The proposed theory indicates that some kinds of luminescent centers, L_i , (as many as the number of peaks)

are present in the irradiated crystal beyond the F centers. The emission of the i -th peak is due to the recombination with L_i centers of the electrons which have been thermally activated from F centers. The equation which rules the kinetics of the process for the peak is $-dN/dt = p_i e^{-E/kT} N.n$, where N and n are respectively the instantaneous concentrations of the L_i and F centers, p_i is the transition probability belonging to the i -th, and E is the activation energy required.

IST.01:014

Istituto Nazionale di Ottica, Florence (Italy).

THE RELATION BETWEEN PUPIL EFFICIENCIES FOR SMALL AND EXTENDED PUPILS OF ENTRY, by A. M. Ercoles, L. Ronchi, and G. T. di Francia. [1956] [6]p. incl. diagrs. (AF 61(514)634-C)
Unclassified

Published in *Optica Acta*, v. 3: 84-89, June 1956.

The authors investigated the magnitude of the apparent brightness produced by rays impinging on the same retinal area (the fovea) at different inclinations. In the measurements the photometric matching fields were illuminated by the method of Maxwellian view. Pupil efficiencies were determined for effective pupils of entry (focussed images in the pupil plane) as follows: a single "pinhole", two pinholes placed either symmetrically or asymmetrically with respect to the

pupil center, full circles and rings centered in the pupil, and finally, semi-circles. The main object was to find if the observed pupil efficiency for the extended pupil of entry patterns could be derived from the observed pupil efficiencies of the parts by applying the additive law. The three observers showed different behavior but in no case was the derived efficiency for an extended pupil of entry pattern greater than the directly observed efficiency (over-additivity). On the other hand, under-additivity does occur. A tentative theoretical explanation of under-additivity is suggested in terms of inhibition and of possible differences of inclination of the axes of the foveal cones. But it is conceivable that a component of inhibition may depend on the color-differences which accompany the Stiles-Crawford effect. (Contractor's abstract)

IST.01:015

Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION. ON THE INFLUENCE OF BOTH SHAPE AND COLOR OF THE LIGHT STIMULUS ON THE HUMAN ELECTRORETINOGRAM, by L. Ronchi and P. Strocchi. [1957] 14p. incl. diagrs. (Technical note no. 9) (AFOSR-TN-57-64) (AF 61(514)634-C) AD 120405
Unclassified

Also published in *Atti Della Fondazione G. Ronchi*, v. 12: 61-69, Jan.-Feb. 1957.

The authors resume and extend an earlier research devoted to the study of the relation between the electroretinogram and the shape of the light stimulus. The predominance of light stimulus showing a slow time gradient of illumination with respect to rectangular stimuli of equal energy has been investigated in white and green (5461A) light. Both types of stimuli turn to be equivalent when blue-violet light (below 4916A) is used. These facts led them to suggest the hypothesis that in the vision of a temporal gradient of illumination an important role is played by those rods which are intermediate between the ideal rods and the cones. (Contractor's abstract)

IST.01:016

Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION. ON THE INFLUENCE OF THE SHAPE OF EQUAL ENERGY LIGHT PULSES ON THE CRITICAL FLICKER FREQUENCY, by L. Ronchi and M. Bittini. [1957] 11p. incl. diagrs. tables, refs. (Technical note no. 10) (AFOSR-TN-57-203) (AF 61(514)634-C) AD 126500
Unclassified

Also published in *Atti Della Fondazione G. Ronchi*, v. 12: 173-179, Mar.-Apr. 1957.

IST.01:017 - IST.01:019

The variation of the critical flicker frequency is investigated as a function of the shape of the light pulses in different retinal locations. The predominance of the saw-tooth stimuli with respect to rectangular stimuli of equal energy is tested in extrafoveal vision, while in foveal vision the critical conditions do not depend on the shape of the light stimuli, in agreement with the classical assumptions. The effect is remarkable when white or green stimuli are used, but disappears when red or blue-violet stimuli are used. The agreement between these results and those obtained taking as response index the b-wave of the electroretinogram elicited by a single flash is stressed. (Contractor's abstract)

IST.01:017

Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION. FOVEAL AND EXTRAFOVEAL CONTRAST THRESHOLD AT A POINT OF A NON-UNIFORM FIELD, by A. Fiorentini. [1957] [11]p. incl. diagrs. (Technical note no. 11) (AFOSR-TN-57-325) (AF 61(514)634-C) AD 132397
Unclassified

Also published in Atti Della Fondazione G. Ronchi, v. 12: 180-186, Mar.-Apr. 1957.

The differential sensitivity of the eye was measured by 2 observers on 6 fields with different luminance gradients. Different slopes were obtained by varying the width of the graded zone while the luminance of the 2 uniform zones was kept constant. The visual angle subtended by the graded zone (angular distance between lines a and b) could take the following values: 7, 12, 18, 25, 33, and 51 min of arc. Three sessions of foveal measurements and 6 of extrafoveal measurements (fixation point at 6° from the test stimulus on the nasal side of the visual field) were made with each of the following fields: 7, 12, 25, 33, and 51 min. The greatest number of observations were carried out with the 18 min field, 15 sessions of foveal measurements and 10 sessions for each of the following conditions: fixation point at 3° from the test stimulus, both on nasal and temporal side, and 6° on nasal side. The results obtained under equal experimental conditions were averaged and plotted separately for the 2 observers. The hypothesis that outside the foveal the differential sensitivity is affected by the presence of the gradient of luminance and not only by its rapid variations appeared to be supported. The foveal mechanism of interaction in the presence of a field with a linear gradient of luminance acts in such a way as to enhance the visibility of the borders of the graded field; for this mechanism a spatial variation of the luminance gradient seems to be particularly effective. The perifoveal mechanism tends to enhance only the visibility of the graded field as a whole, perhaps because of its operating in a retinal area having lower visual acuity.

IST.01:018

Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION. ON THE APPLICATION OF STATISTICAL METHODS TO ELECTRORETINOGRAPHIC RESEARCH, by M. Bittini, I. Nicoletti, and L. Ronchi. Oct. 1957, 24p. incl. illus. diagrs. tables, refs. (Technical note no. 12) (AFOSR-TN-57-682) (AF 61(514)634-C) AD 136672
Unclassified

Also published in Atti Della Fondazione G. Ronchi, v. 12: 462-476, Sept.-Oct. 1957.

A discussion is presented of the human electroretinogram (Erg). Existing literature is surveyed to determine factors which influence the variability of responses. The results are discussed under differences in responses of different subjects to a given light stimulus, and differences in responses of the same subject to a given light stimulus. A statistical analysis is made concerning the scotopic b-wave and the fine structure of the Erg from 2000 available records. Particular attention is given to the response to 2 stimuli with the same energy but different shapes. The statistical validity of the predominance of a saw-tooth stimulus over a rectangular stimulus is discussed. The small wavelet which sometimes appears at the beginning of the b-wave is studied. Evidence is given that this wavelet is caused by cone reaction; no correlation is found between the implicit time of the wavelet and that of the main b-wave, and the frequency of occurrence decreases with increased exposure time. A statistical examination is made of the fast and slow components of the b-wave obtained in response to stimuli of practically unlimited duration and the time of rise ranging between 1 and 60 μ sec.

IST.01:019

Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION, by A. Fiorentini and L. Ronchi. Final rept. Mar. 15, 1954-Oct. 31, 1957, 50p. incl. diagrs. table, refs. (AFOSR-TN-57-99) (AF 61(514)634-C) AD 148032
Unclassified

Research has been performed under the contract on the behavior of the human eye to determine the best conditions for vision and for the interpretation of many types of light signals. General aspects investigated are: (1) the role of the relative motion of an image with respect to the retina; (2) vision of a field with a space gradient of luminance; (3) the influence of drugs such as mydriatics and miotics on vision; (4) the reaction of the dark-adapted retina to a time variation of luminance; and (5) foveal and extrafoveal vision. One important conclusion reached is that detection and recognition are greatly improved by the presence of Mach bands. Therefore, it is useful to make them appear at the edge of an object.

IST.01:020 - IST.01:024

instead of eliminating them. Each section also contains a list of references. (Contractor's abstract, modified)

IST.01:020

Istituto Nazionale di Ottica, Florence (Italy).

[VISION OF FIELDS WITH COMPLEX DISTRIBUTION OF LUMINANCE] Visione di campi con distribuzione complessa di luminanza, by A. M. Ercoles. [1957] [9]p. Incl. illus. diags. (AF 61(514)634-C)

Unclassified

Published in Atti Della Fondazione G. Ronchi, v. 12: 187-195, Mar.-Apr. 1957.

The contrast effect due to a field with a saw-tooth luminance distribution has been investigated. It has been found that the subjective luminance does not differ from that due to a uniform field, when the luminance variations are less than the differential threshold. Further the brightness of the Mach bands due to fields having different luminance distributions have been compared. The Mach band brightness is discussed in terms of the local variation of the luminance gradient.

IST.01:021

Istituto Nazionale di Ottica, Florence (Italy).

BINOCULAR MEASUREMENTS OF BRIGHTNESS ON A FIELD PRESENTING A LUMINANCE GRADIENT, by A. Fiorentini and T. Radici. [1957] [9]p. Incl. illus. diags. tables. (AF 61(514)634-C)

Unclassified

Published in Atti Della Fondazione G. Ronchi, v. 12: 453-461, Sept.-Oct. 1957.

A measurement of the subjective brightness distribution on a field presenting a linear gradient of luminance has been obtained by the method of binocular comparison. The measurements were performed by 2 observers. The comparison field is presented to the left eye only and the test field to the right eye only, so that the comparison field is not affected by the test field. The results of the 2 observers agree qualitatively and the small dispersion of the single experimental points seems to attest the accuracy and soundness of the method used. (Contractor's abstract)

IST.01:022

Istituto Nazionale di Ottica, Florence (Italy).

ON THE INTEGRATIVE PROPERTIES OF THE DARK ADAPTED RETINA: ELECTRORETINOGRAPHIC INVESTIGATION, by L. Ronchi and M. Bittini. [1957] [9]p. Incl. diags. tables. (AF 61(514)634-C)

Unclassified

Published in Atti Della Fondazione G. Ronchi, v. 12: 477-485, Sept.-Oct. 1957.

When blue-violet stimuli are used, at mean luminance levels, the dark adapted retina is found to be able to integrate all the energy received within the latency time of the b-wave, independently of the distribution of the luminance as a function of time. For white (or green) stimuli, this property does not hold: the efficiency of a given amount of energy is greater, the greater is the time of variation of the luminance within the stimulus. (Contractor's abstract)

IST.01:023

Istituto Nazionale di Ottica, Florence (Italy).

ON THE ELECTRICAL RESPONSE OF THE DARK-ADAPTED HUMAN RETINA TO STIMULI PRESENTING DIFFERENT TIME-LUMINANCE DISTRIBUTIONS, by L. Ronchi. [1957] [9]p. Incl. diags. refs. (AF 61(514)-634-C)

Unclassified

Published in Atti Della Fondazione G. Ronchi, v. 12: 560-568, Nov.-Dec. 1957.

A summary is given of a number of researches made during the past 3 yr by the Istituto Nazionale di Ottica, concerning the influence of the shape of the light stimulus on the human electroretinogram. The reaction of the dark-adapted retina to a time variation of luminance has been investigated by measuring the height of the b-wave as well as the latency time and the rate of rise. The scotopic b-wave seems to be due to at least two different types of receptors; one type is able to integrate all the energy received within the latency time (at mean luminance values); for the other type, a given amount of energy is the more effective, the greater is the time of variation of the luminance during the latency time. With slowly rising stimuli of practically unlimited duration it was noticed that, in spite of the large variability of the responses, the slow components of the retinal reaction tend to inhibit the rapid ones. In some cases, the response consists of a slowly rising potential, nearly parallel to the rising of the luminance.

IST.01:024

Istituto Nazionale di Ottica, Florence (Italy).

SIMULTANEOUS CONTRAST EFFECT PRODUCED BY NON-UNIFORM COLOURED FIELDS, by A. M. E. Guzzoni and A. Fiorentini. [1958] [10]p. Incl. diags. tables, refs. (AFOSR-TN-58-675) (AF 61(514)634-C) AD 162207

Unclassified

Also published in Atti Della Fondazione G. Ronchi, v. 13: 135-144, Mar.-Apr. 1958.

The visual contrast effect known as Mach bands, has

IST.01:025, 026; IST.02:001, 002

been investigated using colored fields. It has been found that the Mach lines are produced only by a sharp variation of the gradient of luminance along a given direction, but not by a sharp variation of the gradient of color. The characteristics of a bright Mach band (width and position) visible in a colored field where the gradient of luminance presents a sharp variation, turn out to be independent of the color. The band appears less saturated than the other parts of the field, and the degree of the desaturation has been found to be of the same order of magnitude for green as for red. The hypothesis is advanced that the mechanism responsible for vision of the bright Mach band is achromatic. (Contractor's abstract)

IST.01:025

Istituto Nazionale di Ottica, Florence (Italy).

BRIGHTNESS, WIDTH, AND POSITION OF MACH BANDS AS A FUNCTION OF THE RATE OF VARIATION OF THE LUMINANCE GRADIENT, by A. Fiorentini and T. Radici. [1958] [11]p. incl. diagrs. tables. [AFOSR-TN-58-676] (AF 61(514)634-C) AD 162208 Unclassified

Also published in Atti Della Fondazione G. Ronchi, v. 13: 145-155, Mar.-Apr. 1958.

The characteristics are investigated of the Mach bands perceived in a field where the luminance varies in one direction. Five fields, which differ as to the extent of the graded zone, are tested. The brightness, the width and the position of the Mach bands are measured. It is found that the bright band and the dark band do not have symmetrical positions with respect to the edges of the graded zone, that their brightnesses vary by different amounts when the width of the graded zone decreases, and that the bright band is generally narrower than the dark band perceived in the same field. The lack of symmetry of the two bands is discussed. (Contractor's abstract)

IST.01:026

Istituto Nazionale di Ottica, Florence (Italy).

[CONTRAST EFFECT IN LOOKING AT A FIELD WITH A BLURRY FIXED EDGE] Effet de contraste dans la vision d'un champ avec in bord flou fixe ou mobile, by A. Fiorentini. [1958] [6]p. incl. illus. diagrs. (AF 61-(514)634-C) Unclassified

Presented at the Internat'l. Colloquium on Physical Problems of Color Television, Paris (France), July 2-6, 1957.

Published in Optica Acta, v. 5: 71-76, Jan. 1958.

The presence of blurry edges between two areas of

different luminance produces a particular phenomenon of visual contrast, i.e., two lines are perceived, a bright line and a dark line separating the blurry edge of each area respectively. This phenomenon improves contour perception. It is of importance for television where the transmission of high luminance gradients requires a large frequency band. Luminance measurements have been carried out at various points of a field comprising two areas of different luminance, separated by a linear luminance gradient. Areas luminance levels are within normal television luminance values. Measurements have been carried out by binocular balance. Vision of blurry edges has also been investigated in the case of moving objects. Areas of similar nature, but with vibratory motion in a direction perpendicular to the edges, have been displayed to the observer. It has been found that, as long as movement amplitude and rate remain below certain limit values, area motion actually improves the perception of contrast. (Contractor's abstract)

IST.02:001

Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION. PART 1. ON THE ELECTRICAL RESPONSE OF THE HUMAN EYE TO RED STIMULI OF DIFFERENT SHAPE, by L. Ronchi. PART 2. EFFECT OF PULSE SHAPE ON CRITICAL FLICKER FREQUENCY AT DIFFERENT LUMINANCE LEVELS, by M. Bittini. Jan. 1958 [13]p. incl. illus. tables, refs. (Technical note no. 1) (AFOSR-TN-58-208) (AF 61(052)17) AD 152249 Unclassified

Part 2 also published in Atti Della Fondazione G. Ronchi, v. 13: 47-50, Jan.-Feb. 1958.

Part 1: The responses to red stimuli presenting different distributions of time-luminance are compared. The height of the x-wave seems to be independent of the shape of the light stimulus while the height of the b-wave is greater, the greater the time of variation of the luminance. The latencies to peak of both waves are greater with a slowly rising stimulus than with a steep stimulus. Part 2: The influence of the shape of equal energy light pulses on the critical luminance (L_c) is

investigated at different frequencies of interruption in extrafoveal vision and in dark adaptation (angular diameter of the test field 1'). At low frequencies, fusion with saw-tooth pulses, occurs at a critical luminance lower than with rectangular pulses. The reversal is tested at higher frequencies. The "inversion" point is found just at the frequency value at which the rod branch matches the cone branch in the frequency of interruption against the L_c curve. (Contractor's abstract)

IST.02:002

Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION. PART 1.

IST.02:002 (continued)

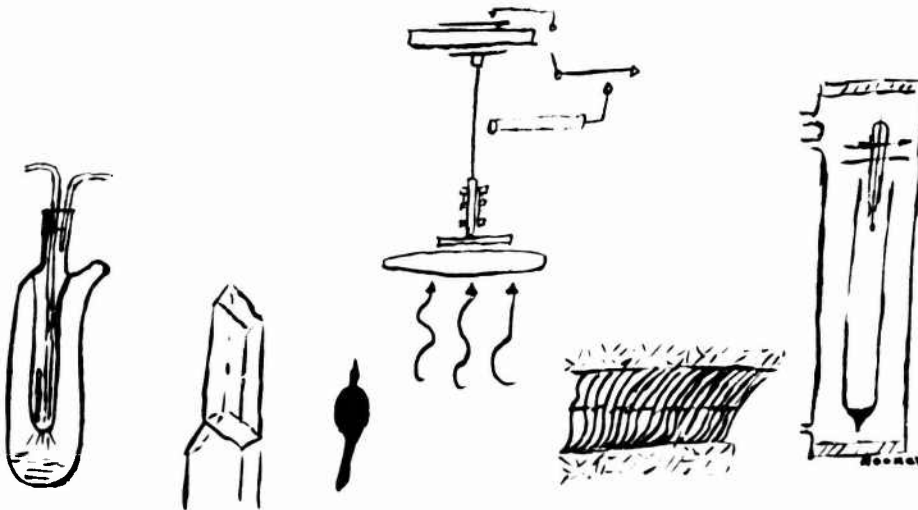
ON THE VARIABILITY OF THE ELECTRICAL RESPONSE OF THE HUMAN EYE TO STIMULI OF DIFFERENT COLOR, by M. Bittini and I. Nicoletti.
PART 2. ELECTRORETINOGRAPHIC RESEARCH ON THE PARAMETERS WHICH DEFINE THE EFFICIENCY OF A LIGHT STIMULUS, by L. Ronchi and I. Nicoletti.
Apr. 1958 [17]p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-58-408) (AF 61(052)17)
AD 158212; PB 136000 Unclassified

Part 1 also published in Atti Della Fondazione G. Ronchi, v. 13: 129-134, Mar.-Apr. 1958.

Part 2 also published in Atti Della Fondazione G. Ronchi, v. 13: 123-128, Mar.-Apr. 1958.

Part 1: The variability of the electroretinographic response obtained from a dark-adapted eye with stimuli of different colors (blue, green, yellow, red) was investigated. Blue or green stimuli elicit in most cases responses which consist of a scotopic b-wave, while

the cone response is either inhibited or revealed only by a small positive wavelet. In the case of red or yellow stimuli the variability of the shape of the electroretinograms appears instead to be great. This effect may be attributed to the fact that, in spite of dark adaptation, rod reaction is impaired by the red stimulation. The responses of the various groups of rods showing different time constants are not synchronized, and multiple waves arise. Part 2: If the scotopic b-wave is taken as an index of the efficiency of a light stimulus at high luminance levels, the efficiency seems to depend on the following parameters: total energy, color, duration, and total time of variation of the luminance. The behavior of the derivative of the luminance does not seem to affect the height of the response, but has some influence on the implicit time in that the response elicited by a slowly rising stimulus is somewhat delayed in time with respect to that elicited by a stimulus containing rapid variations of the luminance. The fine structure of the electroretinogram represented by the ripples on the top of the b-wave appears to be delayed.



JHU. 04:008, 009;
JHU. 05:002, 003

James Forrestal Research Center, Princeton, N. J. see
Princeton U. James Forrestal Research Center, N. J.

Johns Hopkins U., Baltimore, Md.
N6ori-10503, Project Squid see under Princeton U.
James Forrestal Research Center, N. J. (Project
SQUID) item nos. PRI. 11:206 - 209.

JHU.04:008

Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

REVIEW OF SOME RECENT ADVANCES IN THE
UNDERSTANDING OF TRANSITION FROM LAMINAR
TO TURBULENT SHEAR FLOWS, by M. V. Morkovin.
Dec. 1957 [20]p. incl. illus. diagrs. refs. (AFOSR-TN-
57-638) (AF 18(600)1121) AD 136626 Unclassified

Presented at meeting of the Amer. Soc. Mech.
Engineers, New York, Dec. 1-6, 1957.

Also published in Trans. Amer. Soc. Mech. Engineers,
v. 80: 1121-1128, July 1958.

Recent experimental studies of transition from laminar
to turbulent shear flows are reviewed. Certain common
features are emphasized and related to the stability
theories of viscous shear layers. The three-dimen-
sional character, the unsteadiness, and the nonlinear
and random behavior of the latter stages of the transi-
tion process are also examined. (Contractor's abstract)

JHU.04:009

Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

EXTENDED APPLICATIONS OF HOT-WIRE ANE-
MOMETRY TO HIGH-SPEED TURBULENT BOUNDARY
LAYERS, by M. V. Morkovin and R. E. Phinney. June
1958, 1v. incl. illus. diagrs. table, refs. (AFOSR-TN-
58-469) (AF 18(600)1121) AD 158279; PB 136270
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series
II, v. 4: 198, Mar. 30, 1959.

A hot-wire anemometer represents a nonlinear system
consisting of the flow-field, the wire, and the asso-
ciated instrumentation. The method of extracting in-
formation from a heated thin wire, cooled by an un-
steady compressible flow, based on the concept of local
linearization around each operating point of the system,
was extended to wires in yaw and to constant-tempera-
ture systems. An X probe was designed and used for
boundary-layer measurements from which the Reynolds
stress and the energy flux could be obtained. The re-

sults appeared to be consistent with plausible extrapola-
tions of low-speed concepts. Procedures for measure-
ments with single normal wires were clarified and im-
proved. The satisfactory agreement between results of
measurements with sleeved and bare wires made both
of tungsten and platinum-10% rhodium, with a variety of
holders, provided further verification of the rather
complicated methods of measurement and interpretation.
The techniques were applied to the study of the fluctua-
tion structure of a thick fully-developed turbulent bound-
ary layer at $M_1 = 1.77$. (Contractor's abstract)

JHU.05:002

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

THE RELATION OF THE ENTROPY OF FUSION TO
ROTATIONAL-ISOMERISM IN THE STRAIGHT-CHAIN
HYDROCARBON SERIES, by R. H. Aronow and D. H.
Andrews. [1957] [5]p. incl. diagr. (AFOSR-TN-57-86)
(AF 18(600)765) AD 120434 Unclassified

It is expected that the excitation of 3-fold hindered rota-
tions in long chain hydrocarbons adds a term of $R \ln 3$
to the entropy of fusion for each carbon atom added to
the chain. This increase in entropy has been demon-
strated experimentally. It has been concluded that the
concept of structural randomness among the three
rotational positions may be useful in interpreting the
nature of entropy in the liquid state. (See item no.
JHU.05:007)

JHU.05:003

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

A PRECISION METHOD WITH AUTOMATIC RECORD-
ING FOR THE STUDY OF FREEZING POINTS IN
MULTICOMPONENT SYSTEMS, by R. H. Dettre and D.
H. Andrews. Nov. 1957 [58]p. incl. diagrs. tables, refs.
(Technical note no. 1) (AFOSR-TN-57-661) (AF 18-
(600)765) AD 148122 Unclassified

Also published in Jour. Phys. Chem., v. 62: 559-565,
May 1958.

An improved method has been developed for measuring
the temperature of equilibrium between the crystal and
solution phases of multicomponent systems using a con-
stant temperature differential to control rate of cooling
and automatic recording of temperature as a function
of time. This makes possible the determination of true
equilibrium temperature without corrections for under-
cooling. Where crystallization velocities and rate of
attainment of equilibrium are small, this enables one to
obtain the true equilibrium temperature from a study of
the effect of cooling rate on the temperature displace-
ment of the cooling curve. The method has been applied
to the system diphenylmethane-diphenyl ether and com-
pared with other methods. (Contractor's abstract)

JHU.05:004-007; JHU.06:007

JHU.05:004

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

AN AUTOMATIC ADIABATIC CONTROL ADAPTABLE FOR HEAT CAPACITY AND HEAT OF FUSION MEASUREMENTS, by L. J. Todd, R. H. Dettre, and D. H. Andrews. Nov. 1957, 10p. diagrs. table. (Technical note no. 2) (AFOSR-TN-57-772) (AF 18(600)765) AD 148002; PB 132984 Unclassified

Also published in Rev. Scient. Instruments, v. 30: 463-467, June 1959. (Title varies)

An automatic adiabatic shield control has been constructed for a calorimeter designed to measure heat capacities and heats of fusion, using a combination of partial on-off control coupled with an integrating device which keeps the on-cycle equal in length to the off-cycle. A difference thermocouple is the primary source of the control impulse. By calibrating the control with zero heat input, corrections can be made for variations from absolute adiabatic states. Measurements on test compounds indicate a reduction of error due to heat leak to less than 0.1% of the heat to the sample. (Contractor's abstract)

JHU.05:005

Johns Hopkins U. [Dept. of Chemistry] Baltimore, Md.

THE ENTROPY OF FUSION OF LONG CHAIN PARAFFINS (Abstract), by R. H. Aranow, D. H. Andrews, and L. Witten. [1957] [1]p. (AF 18(600)765) Unclassified

Presented at Twelfth Calorimetry Conf., Portsmouth, N. H., Sept. 3-6, 1957.

A number of entropies of fusion of straight chain hydrocarbons have been tabulated from data in the literature. Where entropies of transition have been observed these have been added to the entropies of fusion in the appropriate manner to get an effective total entropy of fusion. A theory has been worked out to account quantitatively for the increase of entropy of fusion with chain length, based on the idea that each CH_2 group has three positions of minimum potential energy and that it is the resulting geometric disorder which accounts for the entropy of fusion increase with chain length. The relation of this theory to other physical chemical properties is discussed.

JHU.05:006

Johns Hopkins U. [Dept. of Chemistry] Baltimore, Md.

SOME OBSERVATIONS ON THE MEASUREMENTS OF HEATS OF FUSION (Abstract), by R. H. Dettre and D. H. Andrews. [1957] [1]p. (AF 18(600)765) Unclassified

Presented at Twelfth Calorimetry Conf., Portsmouth, N. H., Sept. 3-6, 1957.

Using a newly developed automatic adiabatic control designed to take into account rapid variations in rate of heating, measurements have been made of the heat of fusion of diphenyl ether and diphenyl methane. These values have been checked against values obtained from freezing point studies using a new design of freezing point apparatus which permits improvement in the accuracy of observation of the freezing points of binary mixtures. If, as sometimes suggested, there is a loosening of the bonds in the crystal lattice in the range of 10 to 20° below the melting point, this should cause not only an abnormal rise in heat capacity but an abnormal increase in solubility. If, on the other hand, a rise in heat capacity is due to traces of impurity there should not be a correlated increase in solubility. In this particular system, no abnormal changes in solubility were observed in the region below the melting point. The heat of fusion as calculated from the thermodynamic equation for solubility agrees with the value of the heat of fusion obtained calorimetrically if the increase in the heat capacity immediately below the melting point is attributed to impurity. This emphasizes the need for accurate measurements of heat capacity in the region just below the melting point, if proper extrapolation is to be made to obtain correct values of the heat of fusion.

JHU.05:007

Johns Hopkins U. [Dept. of Chemistry] Baltimore, Md.

THE ENTROPY OF FUSION OF LONG CHAIN HYDROCARBONS, by R. H. Aranow, L. Witten, and D. H. Andrews. Nov. 1957 [18]p. incl. diagrs. refs. (Technical note no. 3) (AFOSR-TN-58-88) (AF 18(600)765) AD 148138; PB 131758 Unclassified

Also published in Jour. Phys. Chem., v. 62: 812-816, July 1958.

The entropy of fusion of long chain paraffins is attributed to the onset at melting of the freedom of the molecule to undergo hindered rotation about each carbon to carbon bond. The entropy of fusion increases by a factor close to $R \ln 3$ for each additional CH_2 group added to the chain. Experimental deviations can be used to obtain information concerning the rotational energy levels of the molecules. The melting temperature T_m of the paraffin has been related to the energy level of the first torsional vibrational state E by the empirical relation $T_m \sim E/3k$.

JHU.06:007

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

ISOTOPIC EXCHANGES BETWEEN DIBORANE AND

JHU.06:008 - JHU.06:010

DIHYDROPENTABORANE, by T. E. Larson and W. S. Koski. June 1957 [16]p. incl. diagrs. table. (Technical note no. 6) (AFOSR-TN-57-324) (AF 18(600)1526) AD 132396 Unclassified

Presented at meeting of the Sixteenth Internat'l. Congress of Pure and Appl. Chem., Paris (France), July 18-24, 1957.

Published in Résumés des Communications, v. 1: 157, July 1957.

The kinetics of the exchange of deuterium and B^{10} between diborane (B_2H_6) and dihydropentaborane (B_5H_{11}) were investigated. The order of both exchanges was 0.5 with respect to B_5H_{11} and 1.0 with respect to B_2H_6 . The reaction was a homogeneous one. The ratio of the deuterium rate constant to the boron rate constant was approximately 2. All of the deuteriums and borons and both molecules participated in the exchange. A possible mechanism for the exchange is proposed and consists of a rapid equilibrium between dihydropentaborane and two fragments arising from the dissociation of B_5H_{11} . This is followed by a rate determining bimolecular collision between one of the fragments and diborane resulting in the isotopic exchange. (Contractor's abstract)

JHU.06:008

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

A MASS SPECTROMETRIC APPEARANCE POTENTIAL STUDY OF ISOTOPICALLY LABELED DIBORANES, by W. S. Koski, J. J. Kaufman and others. Feb. 1958, 23p. incl. tables, refs. (Technical note no. 7) (AFOSR-TN-58-157) (In cooperation with Knolls Atomic Power Lab., Schenectady, N. Y.) (AF 18(600)1526) AD 152183 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 3202-3207, July 5, 1958.

The appearance potentials of the molecule ions formed by electron impact from B_2H_6 , $B_2^2H_6$, B_2D_6 , and $B_2^2D_6$ have been measured by means of a mass spectrometer, where B^2 indicates the B^{10} isotope. A set of apparently self-consistent ionization potentials for these molecule ions has been estimated from the appearance potentials of the B^{10} enriched compounds. The resulting calculated ionization potentials for the fragments from $B_2^2H_6$ are compared with the ionization potentials estimated for fragments from $B_2^2D_6$ and are also compared with the results obtained from C_2H_6 . The mass spectra of B_2H_6 , $B_2^2H_6$, B_2D_6 , and $B_2^2D_6$ were also run at 70 ev

ionizing voltage in order to obtain a set of fragmentation patterns of the isotopically labeled diboranes under identical conditions. The mass spectra were used to calculate the monoisotopic spectrum of each type of diborane. (Contractor's abstract, modified)

JHU.06:009

Johns Hopkins U. [Dep't. of Chemistry] Baltimore, Md.

A MASS SPECTROSCOPIC APPEARANCE POTENTIAL STUDY OF SOME BORON TRIHALIDES, by W. S. Koski, J. J. Kaufman, and C. F. Pachucki. Oct. 1958 [23]p. incl. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-58-855) (AF 18(600)1526) AD 203497 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 1326-1331, Mar. 20, 1959.

The appearance potentials of the positive ion fragments from BCl_3 , BBr_3 and BI_3 were measured mass spectroscopically. These measurements permitted a determination of the average B-I bond dissociation energy in BI_3 . A set of apparently self-consistent ionization potentials for the boron trihalides and fragments formed from these molecules has been estimated and compared with ionization potentials of other BY_3 molecules as well as for BY_2 and BY fragments (where Y can be H, halogen or alkyl substituents). Comparison of the ionization potentials of BY_2 radicals indicates an interesting correlation between the ionization potentials and the nature of the group attached to the boron. CY_3 radicals exhibit a similar behavior. The mass spectra of the boron trihalides were also run at 70 ev ionizing voltage to obtain a set of fragmentation patterns under constant conditions. (Contractor's abstract)

JHU.06:010

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

KINETICS OF THE EXCHANGE OF DEUTERIUM BETWEEN DIBORANE AND TETRABORANE, by J. E. Todd and W. S. Koski. Oct. 1958 [17]p. incl. diagrs. tables, refs. (Technical note no. 9) (AFOSR-TN-58-940) (AF 18(600)1526) AD 205086 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 2319-2324, May 20, 1959.

The kinetics of the exchange of deuterium between diborane and tetraborane were found to be complex. The results indicate that the exchange proceeds by 2 different paths—one involves 2 hydrogen positions in tetraborane, and the other involves the remaining 8 or all 10 hydrogen positions. The major reaction is interpreted in terms of a rate-determining reaction of BD_3 from diborane with

JHU.08:002 - JHU.08:006

B_4H_{10} , while the minor reaction is envisaged as a rate-determining activation of 2 sites in tetraborane followed by rapid deuterium exchange with B_2D_6 . Boron atoms also exchange in this system although detailed kinetics studies were not made. (Contractor's abstract)

JHU.08:002

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON A CONJECTURE OF MONTGOMERY, by G. D. Mostow. June 1957, 6p. (AFOSR-TN-57-157) (AF 18-600)1474) AD 126449 Unclassified

Also published in Ann. Math., v. 65: 513-516, May 1957.

Proof is presented for the theorem which states that if G is a compact Lie group operating on a compact manifold M , then there are at most a finite number of inequivalent orbits. A recent result of E. E. Floyd (Ann. Math., v. 65: 505-512, May 1957) is utilized which states that if G is a toroid operating on a compact orientable manifold M , then there are at most a finite number of distinct isotropy subgroups in G .

JHU.08:003

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

EXTENSIONS OF REPRESENTATIONS OF LIE GROUPS II, by G. D. Mostow. Aug. 1957, 27p. (AFOSR-TN-57-439) (AF 18(600)1474) AD 136429 Unclassified

Also published in Amer. Jour. Math., v. 80: 331-347, Apr. 1958.

A discussion is presented of the general problem of extending a representation from a normal closed connected subgroup G to an analytic group L with $L \supset G$. The special case of extending from an ideal G to a semi-direct sum $Q + G$, of the subgroups G and Q is resolved, and a Lie algebra L is reconstructed from an ideal G by successive formation of semidirect sums. Besides the extension methods previously developed (Extension of Representations of Lie Groups and Lie Algebras I, by G. Hochschild and G. D. Mostow), a new technique is set down which relies on the theory of algebraic groups, particularly on fully reducible subgroups of algebraic groups.

JHU.08:004

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

[THEORY OF INVARIANTS], by G. D. Mostow. Final technical rept. Aug. 1, 1955-July 31, 1958, 4p. (AFOSR-TR-58-101) (AF 18(600)1474) AD 162219; PB 136866 Unclassified

Research performed under this contract dealt mainly with 2 facets of the theory of Lie groups which involve distinctively different methods of analysis. Problems were investigated relating to the representations of a Lie group by linear transformations of a linear space and relating to the operations of a Lie group as a group of topological transformations on a manifold. Good results were obtained with problems related to the ring of representative functions of a Lie group.

JHU.08:005

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

TOROID TRANSFORMATION GROUPS ON EUCLIDEAN SPACE, by D. Montgomery and G. D. Mostow. [1958] [23]p. incl. refs. [AF 18(600)1474] Unclassified

Published in Illinois Jour. Math., v. 2: 459-481, Dec. 1958.

This paper deals with the action of an r -dimensional toroid G on a space X . The intersection of the isotropy groups G_y , $y \in Y \subset X$, is called the fixer of Y . For $H \subset G$, $H^+(G)$ is the intersection of all the fixers containing H . A point x of X is a weight point if G_x is $(r-1)$ -dimensional; the homomorphism $G \rightarrow G/G_x$ is the weight associated with x . A fixed point of $H \subset G$ is a point which is fixed under each element of H . The fixed set $F(H)$ of H consists of its fixed points. A star circle subgroup of G is a circle subgroup whose fixed set is not the fixed set of any connected subgroup property containing it. It is shown that if X can be compactified to a cohomology n -sphere over the integers by adding a single point ∞ , and if G acts almost effectively, then G is spanned by its star circle subgroups, $0 < \dim F(G) \leq n-2r$ and $F(G) \cup \infty$ is a cohomology sphere. If G acts effectively and $n = 2r$ or $2r+1$, then G has exactly r star circle subgroups; all fixer subgroups are connected; $(ST)^+ = S^+ T^+$ for any two subgroups S and T ; G has exactly r weights, 2^r fixer subgroups and 2^r isotropy classes. In case X is HLC and $n \leq 2r+1$, it is shown that the set U of points with trivial isotropy subgroups decomposes as $B \times G$, where B is a euclidean-like cohomology manifold. (Math. Rev. abstract)

JHU.08:006

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

REPRESENTATIONS AND REPRESENTATIVE FUNCTIONS OF LIE GROUPS. II, by C. Hochschild and G. D. Mostow. [1958] [9]p. (AF 18(600)1474) Unclassified

Published in Ann. Math., v. 68: 295-313, 1958.

This paper is a continuation of part I, hereafter referred

JHU.09:004 - JHU.09:006

to as RFGI [Ann. Math., v. 66: 495-542, 1957]. We continue here with some of the notation of that review. Let G be a Lie group, $R(G)$ the algebra of representative functions on G , A the group of proper automorphisms of $R(G)$, G^+ the universal complexification of G , and let t, t^+ be, respectively, the natural homomorphisms of G and G^+ into A . Also let γ be the homomorphism of G into G^+ implicitly defined in RFGI. The main results of RFGI had to do with a type of group referred to as a Tannaka group in our review of RFGI.

Here G^+ and $R(G)$ are investigated under more general circumstances. An early result settles the question of the existence of a locally faithful representation of G in the following way. Let G' be the commutator subgroup of G , S a maximal semisimple analytic subgroup of G , and T the radical of G' . Then G has a locally faithful representation if and only if the following conditions are satisfied: (1) G' is closed in G , (2) T is simply connected, and (3) $S \cap T = \{1\}$. A corollary then asserts that if G is solvable, connected, the existence of a locally faithful representation implies the existence of a faithful representation. Observe that $\text{Hom}(G, \mathbb{C})$ and $\text{Hom}(G, \mathbb{C}^*)$ are subsets of $R(G)$. Let \exp denote the map from $\text{Hom}(G, \mathbb{C})$ to $\text{Hom}(G, \mathbb{C}^*)$ given by exponentiation. Also let Q denote the image of \exp . Now for any $\alpha \in A$ and any $h \in R(G)$ put $\alpha'(h) = \alpha(h)(1)$. The following characterization of the subgroup $t^+(G^+)$ of A is then given. Let $\alpha \in A$. Then $\alpha \in t^+(G^+)$ if and only if $\alpha'(\exp h) = \exp(\alpha'(h))$ for all $h \in \text{Hom}(G, \mathbb{C})$. Under certain assumptions the following result on the structure of $R(G)$ is obtained. Let P be the kernel of t . Then the following conditions are equivalent. (1) The factor group of the radical of G/P modulo its maximal nilpotent normal analytic subgroup is compact. (2) There is a finitely-generated translation and complex conjugation stable subalgebra U of $R(G)$ such that $C + \text{Hom}(G, \mathbb{C}) \subset U$, $R(G) = U[Q]$ and the elements of Q are free over U . (3) G^+ is isomorphic with an algebraic group of complex linear transformations of a space $C \otimes V$ where V is a real vector space stable under $\gamma(G)$. It is also proved that for a group satisfying any one of the (equivalent) conditions of the theorem above the structure of A is given by $A = W \times t^+(G^+)$ where W is isomorphic to $\text{Hom}(Q, \mathbb{C}^*)$. (Math. Rev. abstract)

JHU.09:004

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON A THEOREM OF FROBENIUS, by P. Hartman. Feb. 1957, 17p. (Technical rept. no. 4) (AFOSR-TN-57-66) (AF 18(603)41) AD 120408 Unclassified

Proof is given for Frobenius' theorem which states that if w_1, \dots, w_h denote h linearly independent linear forms

in dx^1, \dots, dx^n with continuous coefficients in $|x| < 1$

possessing continuous exterior derivatives w_1, \dots, w_h and satisfying the integrability conditions $w_1 \dots w_h w_j = 0$ for

$j = 1, \dots, h$, then in a vicinity of $y = 0$ there exists a mapping $x_j = x_j(y^1, \dots, y^n)$ for $j = 1, \dots, n$, which satisfies $x(0) = 0$ of class C^1 with nonvanishing Jacobian,

$\det \frac{\alpha x^j}{\alpha y^k} \neq 0$, and which transforms w_1, \dots, w_h into linear

forms in dy^1, \dots, dy^n (with coefficients which are continuous functions of y^1, \dots, y^n). The integrability conditions are necessary and sufficient for the assertion of the theorem. The proof is deduced from 3 lemmas on the local uniqueness of solutions of nonlinear systems of ordinary differential equations. The first depends only on the boundedness of the coefficients in the exterior derivative of w_j ; the second requires continuity, and the third proves that under certain of the given conditions, the resulting matrix is independent of a certain scalar.

JHU.09:005

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON HÖLDER CONTINUITY AND NON-LINEAR ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS, by P. Hartman. Apr. 1957, 13p. (Technical rept. no. 5) (AFOSR-TN-57-175) (AF 18(603)41) AD 126470 Unclassified

Also published in Duke Math. Jour., v. 25: 57-65, Mar. 1958.

A discussion is presented of the estimates for the degree of continuity of mappings $(x, y) \rightarrow (p, q)$ subject to inequalities of the form $p_x^2 + p_y^2 + q_x^2 + q_y^2 \leq \text{const.}$

$\partial(p, q)/\partial(x, y) + \text{const.}$ The results are applied to the question of the Hölder continuity of second order derivatives of a solution of a second-order, elliptic partial differential equation in 2 independent variables. In particular, a crude but useful form of E. Hopf's (Math. Zeltschr., v. 34: 194-233, 1932) interior estimates for the case of 2 independent variables result very simply, without the use of potential theory. (Contractor's abstract)

JHU.09:006

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON EXTERIOR DERIVATIVES AND SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS, by P. Hartman. July 1957, 14p. (Technical rept. no. 6) (AFOSR-TN-57-344) (AF 18(603)41) AD 132417 Unclassified

Also published in Trans. Amer. Math. Soc., v. 91: 277-293, May 1956.

JHU.09:007, 008; JHU.20:001

Some applications are made of lemmas on local uniqueness and smoothness of solutions of systems of ordinary nonlinear differential equations. These imply results dealing with the local uniqueness of geodesics and the introduction of parallel or polar geodesic coordinates for binary Riemannian metrics. The results are extended from 2 to n dimensions and from geodesics to solutions of more general Euler-Lagrange systems. The assertions established are generalized to become applicable to problems of extremals for more general parametric problems of the calculus of variation.

JHU.09:007

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON MAXIMUM PRINCIPLES FOR NON-HYPERBOLIC PARTIAL DIFFERENTIAL OPERATORS, by P. Hartman and R. Sacksteder. Aug. 1957, 20p. incl. refs. (Technical rept. no. 7) (AFOSR-TN-57-501) (AF 18-603)41 AD 136491
Unclassified

Also published in Rend. Circ. Matem. Palermo, Series II, v. 6: 218-232, May - Aug. 1957.

Let A, B, C, D, E be defined on an (x, y) -domain T with a boundary T' . The differential operator $Lz = Az_{xx} + Bz_{xy} + Cz_{yy} + Dz_x + Ez_y$ is said to have a weak maximum principle on T if $\max_{T \cup T'} z = \max_{T'} z$

holds for every function which is of class C^2 on $T \cup T'$ and which is of class C^2 and satisfies $Lz \geq 0$ on T . The following conditions are assumed and referred to as hypothesis H: (1) T is a bounded domain; (2) A, B, C, D, E are continuous functions on T which satisfy the inequalities $AC - B^2 \geq 0$ and $A^2 + B^2 + C^2 > 0$ and $A > 0$, hence $C \geq 0$; z is of class C^2 ; and (3) z is continuous on $T \cup T'$ and m denotes its maximum, $m = \max_{T \cup T'} z(x, y)$ on $T \cup T'$. The main result states: let H hold and $z(x, y) \neq m$ on every open subset of T ; let $z = m$ hold at a point (x_0, y_0) of T ; then there exists a characteristic arc passing through (x_0, y_0) on which $z = m$. This theorem is proved and used to derive some weak maximum principles and strong maximum principles, and to study the behavior of z at a point of T' where $z = m$. (ASTIA abstract)

JHU.09:008

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON SOLUTIONS OF $\Delta V + V = 0$ IN AN EXTERIOR REGION, by P. Hartman. Nov. 1958, 12p. (Technical rept. no. 8) (AFOSR-TN-58-984) (AF 18(603)41) AD 205914; PB 139632
Unclassified

Also published in Math. Zeitschr., v. 71: 251-257, 1959.

Let $V = V(x)$ be a solution of $\Delta V + V = 0$ in the entire p -dimensional x -space subject to the boundedness condition:

$$R^{-1} \int_{|x| < R} |V|^2 dx \leq C. \text{ For fixed } r, \text{ let}$$

$V(x) = V(ru)$, where $|x| = r$ and $u = x/|x|$, have the

Fourier development (1) $r^{\frac{1}{2}(p-1)} V(ru) \sim (2\pi r)^{\frac{1}{2}}$

$\sum_{n=0}^{\infty} i^n c_n J_{\mu}(r) K(u)$ in terms of normalized spherical

functions $K_{\mu}(u)$ and Bessel functions of order $\mu =$

$n + \frac{1}{2}(p-2)$. It is shown that if $(2\pi r)^{\frac{1}{2}} J_{\mu}(r)$ is replaced by its approximation $2 \cos(r - \frac{1}{2}\mu\pi - \pi/4)$, the right side becomes a function $W(ru)$ which is an approximation to $V(ru)$ for large r in the sense that (2)

$$R^{-1} \int_{|x| < R} |V - W|^2 dx \rightarrow 0 \text{ as } R \rightarrow \infty. \text{ This leads to}$$

an easy proof of Magnus's theorem [Abh. Math. Sem. Univ. Hamburg]. An analog of the asymptotic formula is also obtained for solutions $V(x)$ of $\Delta V + V = 0$ defined only for large $|x|$. (Contractor's abstract)

JHU.20:001

Johns Hopkins U. Dept. of Mechanical Engineering, Baltimore, Md.

BOUNDARY LAYER ALONG ANNULAR WALLS IN A SWIRLING FLOW, by H. Yeh. Mar. 1957, 30p. diagrs. (AFOSR-TN-57-105) (AF 18(600)991) AD 120455
Unclassified

Presented at meeting of the Amer. Soc. Mech. Engineers, San Francisco, Calif., June 9-13, 1957.

Also published in Trans. Amer. Soc. Mech. Engineers, v. 80: 767-776, May 1958.

The development of incompressible boundary layers along concave and convex stationary annular walls are investigated analytically and experimentally for a swirling flow, i.e., flow with both tangential and axial mean velocities. It was found that the integral momentum equation describing this type of boundary layer contains three correction terms to the conventional equation. The combined influence of these corrections appears to promote the growth of the boundary layer next to a concave wall. Other differences between the boundary layers with swirl and those without swirl are pointed out and interpreted. Measurements on turbulence intensities appear to confirm such interpretations.

JHU. 21:001, 002; JHU. 11:002; JHU. 22:001

JHU.21:001

Johns Hopkins U. Dept. of Mechanical Engineering,
Baltimore, Md.

NOTE ON A THERMOELASTIC PROBLEM FOR A
TRANSVERSELY ISOTROPIC HOLLOW SPHERE EM-
BEDDED IN AN ELASTIC MEDIUM, by J. Nowinski.
[July 1958] [2]p. (AFOSR-TN-58-578) (AF 49(638)377)
AD 231592 Unclassified

Also published in Jour. Appl. Mech., v. 26: 649-650,
Dec. 1959.

This note generalizes the Galerkin problem to consider thermoelastic stresses in anisotropic bodies with an axis of symmetry. Stresses are obtained in a hollow sphere of 2 different transversely isotropic or Winkler material (i.e., isotropic in a plane perpendicular to the radius vector) layers when the sphere is subjected to an internal pressure and spherically symmetrical temperature field. The sphere is embedded in an elastic medium which is also considered to be transversely isotropic. In the limiting case, the form of the Winkler coefficient is indicated for an isotropic material.

JHU.21:002

Johns Hopkins U. [Dept. of Mechanical Engineering]
Baltimore, Md.

AXIALLY SYMMETRICAL PROBLEM FOR A
RESTRICTED TYPE OF A CYLINDRICALLY ANISO-
TROPIC ELASTIC MEDIUM, by J. Nowinski. [1958] 5p.
(AFOSR-TN-58-579) [AF 49(638)377] AD 158401
Unclassified

It is the purpose of the present paper to generalize the analysis developed by Lekhnitsky, Eubanks, and Sternberg, for transversely isotropic problems, to cylindrically orthotropic medium. The fundamental differential equation is solved for the following particular cases: (a) when it may be represented as a product of two modified Laplace operators (this implies a higher elastic symmetry, restricted by an additional relation), then the Hankel transformation has been used; (b) when the solution may be represented in a form of a product of a sine, cosine or exponential function of the variable z , and a function of the variable r , only; and (c) when the solution may be represented in a form of a combination of homogeneous integer polynomials. Some general examples concerning a half-space and a thick circular plate have been solved for illustration.

JHU.11:002

Johns Hopkins U. [Dept. of Medicine] Baltimore, Md.

PHYSICAL PRINCIPLES OF VECTOR BALLISTO-

CARDIOGRAPHIC MEASUREMENT, by S. A. Talbot.
Final rept. Mar. 22, 1954-Mar. 22, 1958. June 1958, 1v.
Incl. illus. diagrs. refs. (AFOSR-TR-58-72) (AF 18-
(600)1107) AD 158301; PB 135626 Unclassified

An attempt was made to establish better techniques as well as improved understanding of the relationship between ballistocardiography (BCG) records and hemodynamic events. Attention was directed toward developing a first-order theory and experimental method for analyzing cardiovascular vector ballistics. A clear statement is presented on the pros and cons of a physical model able not only to provide the necessary basis for quantitatively dealing with the vector mechanics involved, but also incorporating enough of the biological realities to be meaningful. The symmetry properties of a recumbent human and the location of the cardiovascular acceleration patterns focused interest on the separation of dynamical variables possible in the transverse plane. The problem is discussed of a physical structure which is sufficiently light and rigid in all deflections and torsions to transmit without vibrational artifact the high stresses associated with gimbaling the body axially. The theory of liquid suspensions for correct frontal-plane BCG recording was scrutinized. In addition, the importance of frequency analysis of the BCG on a clinical scale was explained. (ASTIA abstract)

JHU.22:001

Johns Hopkins U. [Dept. of Medicine] Baltimore, Md.

PHYSICAL BASIS OF CARDIOVASCULAR SOUND.
AN ANALYTICAL SURVEY, by H. K. Wiskind and S. A. Talbot. Dec. 1958, 118p. Incl. illus. diagrs. table, refs.
(AFOSR-TR-58-160) (AF 18(600)1337) AD 207459;
PB 140955 Unclassified

Cardiovascular sound is analyzed by relating observed phenomena to the basic concepts of physics through quantitative theoretical and experimental analysis of models. An account of simple observations of the sounds of a cavitating water jet and of an underwater vortical sound generator is given. Detailed analyses of vibrations in the human anatomy are presented. Three idealized models were investigated: (1) Monopole radiation in a model of the heart and chest having spherical symmetry. The "musical" murmur produced by an aortic regurgitant jet might be an example of such monopole radiation and it is discussed in quantitative terms. (2) Axisymmetric waves at acoustic frequencies in the blood-aorta system (waves down a viscoelastic tube containing an incompressible fluid). (3) General properties of extended tissue as an extended acoustic medium (vibrations in an isotropic viscoelastic medium with calculations of the impedance to a dipole). The development work on two types of instruments designed to measure the dynamic dilations of compliant tubes is described. The possibility of noisy murmurs being generated by turbulent blood flow is explored, and the problem of the possible

JHU.12:002, 003;
JHU.13:002, 003

effect of compliant vessel walls on the turbulent flow is briefly analyzed. (Contractor's abstract)

JHU.12:002

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

ION BALANCE AND LIGHT EMISSION IN THE HELIUM AFTERGLOW (Abstract), by D. E. Kerr and M. N. Hirsh. [1958] [1]p. [AF 18(600)363]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 258, June 19, 1958.

In the afterglow following a pulsed discharge at pressures from 3 to 20 mm Hg in helium, the time dependence of I/n , the ratio of intensity of emitted molecular bands to electron density, suggests: (1) the light results from recombination between an electron and a He_2^+ ion;

(2) at late afterglow times the rate of loss of He_2^+ ions by recombination is much smaller than that by the predominant mechanism of ambipolar diffusion which occurs at a measured rate expressed by a value of D_p of 794.

The light intensity is not, in general, proportional to the square of the electron density. The electron density variation at late times reveals simultaneous loss by ambipolar diffusion and creation by collisions between metastable molecules. The ion so created may be He_2^+ , or it may be He^+ , which is rapidly converted by three-body collisions to He_2^+ . The creation of these ions is not reflected in the time dependence of the I/n ratio. We suggest that these ions may be formed in high vibrational states which do not yield molecular light directly or participate in collisional de-excitation to the ionic ground state (which we assume does yield molecular light by recombination). Various possible types of recombination mechanisms will be discussed.

JHU.12:003

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

CHARGE REMOVAL IN LOW-ENERGY PLASMAS (Abstract), by D. E. Kerr. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274) [AF 18(600)363]
Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

Measurements of electron density in, and light radiated from decaying plasmas have been interpreted by some observers as indicating values of volume recombination coefficients as high as $10^{-6} \text{ cm}^3/\text{sec}$. Such large values

cannot result from simple radiative recombination, and other processes, such as dissociative recombinations, have been invoked. Careful examination of details of experimental procedure and of analysis and interpretation of the data raise doubt as to whether the large apparent electron loss rates are the result of volume recombination. A detailed study of recombination between electrons and He_2^+ ions shows the recombination coefficient to be certainly much less than 10^{-8} , but not less than $10^{-10} \text{ cm}^3/\text{sec}$. A critical discussion will be given of the numerous factors involved in interpretation of data leading to the results above. Connections will be shown with such basic atomic processes as: formation of excited states of molecular and atomic neutral and ionic species, destruction of these states by radiation and collisional quenching and collisions between metastable atoms. A discussion is also given of the limitations of the methods of measurement.

JHU.13:002

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

RADIATIVE TRANSITION IN PROTONIUM, by T. Fulton. Feb. 27, 1957, 7p. (Rept. no. HER-1) (AFOSR-TN-57-93) [AF 18(603)143] AD 120441
Unclassified

On the basis of preliminary estimates made from presently available data, the possibility of observing the radiative $2P - 1S$ transition in the hydrogen-like bound state of a proton and antiproton is suggested. A significant correction to the energy of such a transition would be provided by the nuclear interaction. The measurement of the transition energy could therefore be used to obtain a value of the scattering length for proton-antiproton scattering. (Contractor's abstract)

JHU.13:003

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

ANGULAR DISTRIBUTION OF K^+ MESON DECAY PRODUCTS (Abstract), by E. B. Brucker and G. Fazio. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Office of Naval Research, and Atomic Energy Commission)
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 236, Apr. 25, 1957.

On the chance that the K^+ meson has spin greater than zero and is polarized when it is brought to rest in a stack of nuclear emulsions, several hundred stopped K_L mesons have been analyzed to detect an asymmetry of

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the charged particle decay. Preliminary analysis by octants shows no evidence for an asymmetry. However, detailed angular distributions are now being plotted and are presented. Several possible causes for the lack of asymmetry are discussed. In addition, the angular distribution for 50 events definitely established as $K_{\mu 2}$ are presented.

JHU.13:004

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

PHENOMENOLOGICAL NEUTRON-PROTON POTENTIALS, by R. G. Newton and T. Fulton. [1957] [9]p. incl. diagrs. refs. [AF 18(603)143] Unclassified

Published in Phys. Rev., v. 107: 1103-1111, Aug. 15, 1957.

Central, tensor, and spin-orbit potentials are calculated for the neutron-proton triplet state. They allow explicit solution of the Schrödinger equation and fit the low-energy data: effective range, scattering length, deuteron binding energy, quadrupole moment, and D-state probability. The deuteron wave function as well as scattering wave functions which result from these potentials are also computed. The potential and wave functions which fit the low-energy singlet state data are also obtained. (Contractor's abstract)

JHU.13:005

Johns Hopkins U. Dept. of Physics, Baltimore, Md.

ENERGY DEPENDENCE OF THE K^+ - MESON INTERACTION CROSS SECTION, by M. Wiggoff, A. Pevsner and others. [1957] [4]p. incl. diagr. tables, refs. [AF 18(603)143] Unclassified

Published in Phys. Rev., v. 107: 1430-1433, Sept. 1, 1957.

K^+ interactions in nuclear photographic emulsion have been studied at three effective mean K^+ energies: 54 mev, 95 mev, and 140 mev. The cross section for inelastic interaction is found to increase slightly with energy. The scattering appears to be s-wave, $T = 1$, at low energies, with p-wave scattering becoming appreciable above about 100 mev. (Contractor's abstract)

JHU.13:006

Johns Hopkins U. Dept. of Physics, Baltimore, Md.

STRIPPING TYPE NUCLEAR REACTIONS, by T. Fulton and G. E. Owens. [1957] [6]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)143 and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 108: 789-794, Nov. 1, 1957.

An exact formal expression is derived which treats the initial and final states of a nuclear reaction in a symmetric manner. The specific example treated is the (d,n) reaction. The Coulomb interaction is not taken into account. Estimates of some of the terms of the general expression which is obtained provide some indication of the reasons for the similarity of the final results of the various approaches to direct interaction. One of the terms of the development includes effects of compound-nucleus formation. Suggestions are made for a single-particle model of the intermediate state. The process of exchange and heavy-particle stripping is incorporated into the formalism in the Appendix. (Contractor's abstract)

JHU.13:007

Johns Hopkins U. Dept. of Physics, Baltimore, Md.

A POSSIBLE THEORY OF BETA DECAY INTERACTION (Abstract), by R. Arnowitt and G. Feldman. [1957] [1]p. [AF 18(603)143] Unclassified

Recent data suggest that positron and electron beta decays occur through different interactions. A relativistically covariant theory is proposed to account for the data. The theory violates the TCP theorem, though many consequences of this theorem can be maintained.

JHU.13:008

Johns Hopkins U. Dept. of Physics, Baltimore, Md.

TESTS OF THE TCP THEOREM IN MESON DECAYS (Abstract), by R. Arnowitt and G. Feldman. [1957] [1]p. [AF 18(603)143] Unclassified

The consequences of the violation of the TCP theorem in meson decays (for theories of the type previously discussed in beta-decay theory) are considered. It is shown that all the present verifications of the TCP theorem can still be accounted for. Several possible experiments that can distinguish between theories that do and do not have the TCP symmetry are discussed.

JHU.13:009

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

POLARIZATION OF THE RECOIL NUCLEUS IN $\bar{\mu}$ -CAPTURE, by T. Fulton. Dec. 20, 1957, 5p. (AFOSR-TN-58-31) [AF 18(603)143] AD 148070 Unclassified

Also published in Nuclear Phys., v. 6: 319-322, Mar. 1958.

JHU.13:010 - JHU.13:013

The complete expression is calculated for the allowed nonrelativistic transition rate of μ -capture from the atomic K-shell. It is used to obtain the expression for the polarization of the recoil nucleus. As is well known, the polarization term governs the asymmetry in the subsequent beta decay. If the incident μ are unpolarized, the polarization of the recoil following μ -capture in a Gamow-Teller transition can in principle distinguish between the coupling constants suggested by Lee and Yang and by Feynman and Gell-Mann. (Contractor's abstract)

JHU.13:010

Johns Hopkins U. Dept. of Physics, Baltimore, Md.

KNOCK-ON SCATTERING OF POLARIZED μ MESONS ON ALIGNED ELECTRONS, by T. Fulton and L. Madansky. Jan. 20, 1958, 4p. (AF 18(603)143)
Unclassified

The knock-on scattering of polarized μ mesons on aligned electrons is to be used to measure the helicity of the μ meson. The following experiment is proposed: μ mesons chosen from forward decays of π mesons are directed on a block of magnetized iron with electron spins parallel and antiparallel to the μ beam. The cross section for the knock-on electrons is then to be compared in the two cases. Thus far the μ meson beams obtained are not sufficiently energetic enough to provide significant spin contributions.

JHU.13:011

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

DETERMINATION OF THE RELATIVE $\Sigma - \Lambda$ PARITY, by G. Feldman and T. Fulton. Apr. 28, 1958, 10p. (AF 18(603)143)
Unclassified

Also published in Nuclear Phys., v. 8: 106-112, Sept. 1958.

An investigation has been undertaken to determine whether there are definitive experiments which can determine, at least in principle, the relative $\Sigma - \Lambda$ parity. Two such methods are discussed. They are both based upon the parity-conserving electromagnetic decays of the Σ^0 . The first involves the process $\Sigma^0 \rightarrow \Lambda^0 + \gamma$. It is necessary to measure the decay asymmetries of the Λ^0 together with the direction of the photon polarization. The second method (also calculated recently by Feinberg) involves an accurate measurement of the branching ratio for the reactions $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$ and $\Sigma^0 \rightarrow \Lambda^0 + \gamma$. The appendix is concerned with some properties of a general vertex part. (Contractor's abstract)

JHU.13:012

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

HIGH-ENERGY ELECTRON BREMSSTRAHLUNG FROM AN EXTENDED PROTON (Abstract), by D. Moroi, M. Dresden, and T. Fulton. [1958] [1]p. [AF 18(603)143]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Buil. Amer. Phys. Soc., Series II, v. 3: 184, May 1, 1958.

A calculation has been made of the energy and angular distribution of electrons and photons arising from the bremsstrahlung of high-energy electrons on an extended proton. The form factors describing the charge and current distribution of the proton are the ones used in the interpretation of the Stanford experiments on the elastic scattering of electrons on protons. The calculation is patterned after the usual bremsstrahlung calculation, and uses the Born approximation. As might be anticipated, the main effect of the extended charge and current, as contrasted with the point charge, is to be found in the distribution of those electrons and photons which are scattered through an appreciable angle with respect to the initial momentum direction. From these distributions, it is in principle possible to obtain independently both the complete charge and the complete current form factors. It is believed that the use of the Born approximation is justified, particularly since the main effect is important for large angles only. The influence of processes such as electron-electron bremsstrahlung, exchange terms, and nuclear recoil, can be computed and must be taken into account to obtain information about the form factors from the bremsstrahlung spectrum.

JHU.13:013

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

MASS OF THE Λ^0 -HYPERON (Abstract), by E. B. Brucker, F. Anderson and others. [1958] [1]p. [AF 18(603)143]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cornell U., Ithaca, N. Y., June 19-21, 1958.

Published in Buil. Amer. Phys. Soc., Series II, v. 3: 271, June 19, 1958.

A program has been instituted to measure the Q value of the reaction $\Lambda \rightarrow \pi^- + p$. A G-5 stack was exposed at the bevatron to a K^- beam of 300 mev/c. The pellicies are now being area scanned. Many two-pronged events with a π^- and proton, both stopping in the emulsion, have been found and measured. Corrections to the raw Q values are now being applied. The results will be presented.

JHU.13:014; JHU.16:003, 004;
JHU.17:002, 003

JHU.13:014

Johns Hopkins U. Dept. of Physics, Baltimore, Md.

THE POLARIZATION OF KNOCK-ON ELECTRONS ARISING FROM SCATTERING BY POLARIZED μ -MESONS, by D. Fivel and T. Fulton. [1958] [8]p. incl. table. [AF 18(603)143] Unclassified

Published in Nuovo Cimento, Series X, v. 10: 682-687, Nov. 16, 1958.

An experiment is proposed for the direct measurement of the helicity of μ -mesons arising from π decay by studying the polarization of the high energy electrons produced in the collision of the polarized μ -mesons with unpolarized electrons. Polarization effects become significant only for muon energy of the order of a few gev. The separation of a polarized beam of μ -mesons from the decays in flight of high energy π 's is in principle made easier by the fact that the laboratory momenta of μ -mesons which are emitted in the forward and backward directions in the π rest system differ by about 42% as a consequence of the relativistic transformation from the center of mass to the laboratory system. Expressions in the laboratory frame are also given of the cross section for scattering polarized electrons by polarized μ -mesons. In the center of mass frame, the results agree with those calculated by Bincer. (Contractor's abstract)

JHU.16:003

Johns Hopkins U. [Inst. for Cooperative Research]
Baltimore, Md.

STUDIES IN A NEW TYPE OF FLAT FLAME BURNER, by W. T. Biedler, III and H. E. Hoelscher. [1957] [4]p. incl. illus. diagrs. (AF 18(600)1176) Unclassified

Published in Jet Propulsion, v. 27: 1257-1260, Dec. 1957.

A new type of device for measuring flame velocities has been developed. This device is a burner utilizing a stable planar flame front which permits the study of stable flat flames, free from contact with any surface. Flame velocity as a function of concentration of combustible in the unburnt mixture has been determined for an air-propane system. The effect of the geometry of the system on flame properties is observed and discussed. Temperature and concentration measurements were made in the vicinity of the flame and are reported. (Contractor's abstract)

JHU.16:004

Johns Hopkins U. Inst. for Cooperative Research,
Baltimore, Md.

RESEARCH ON COMBUSTION RATES IN FUEL-AERO-

SOL VAPOR MIXTURES, by H. E. Hoelscher. Final rept. Nov. 1958, 1v. incl. diagrs. refs. (AFOSR-TR-58-165) (AF 18(600)1176) AD 208081; PB 139605 Unclassified

Two new flame systems have been defined: (1) the free flat flame described by Biedler and Hoelscher; and (2) the traveling flame developed by Levine and Weger. The former is most applicable to studies of the kinetics of combustion reactions, whereas the latter is most properly directed toward the study of flame stability. The operating characteristics of these two flame systems have been studied and described. The optimum direction for future research on these problems had been indicated. (Contractor's abstract, modified)

JHU.17:002

Johns Hopkins U. [Inst. for Cooperative Research]
Baltimore, Md.

EFFECT OF DISLOCATIONS AND GRAIN BOUNDARIES UPON THE DYNAMIC FORMATION OF SLIP BANDS IN ALUMINUM, by D. F. Haskell and R. B. Pond. May 1957 [54]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-223) (AF 18(600)1587) AD 126521 Unclassified

A free grain boundary is found to have no effect upon the velocity of propagation of slip bands in aluminum. The method is explained by which a free grain boundary may be obtained by means of a 180° rotation about the longitudinal axis of an aluminum single crystal. Also, it is determined that the average slip band velocity in a crystal is not affected by the average stch-pit density of the crystal; but that the slip velocity of propagation of nearest neighbor slip bands occurring in sequence is proportional to the average stch-pit density. The crystallography of the slip systems which activate in a bi-crystal containing a free grain boundary is discussed, and a relation between crystallography and slip band velocity is proposed. Slip activation may occur at a free grain boundary. (Contractor's abstract)

JHU.17:003

Johns Hopkins U. [Inst. for Cooperative Research]
Baltimore, Md.

CINEMOGRAPHIC RECORDING OF MULTIPLE BEAM INTERFEROMETRIC FRINGES DURING PLASTIC DEFORMATION OF SINGLE CRYSTALS, by R. B. Pond and E. [H.] Harrison. 1957 [2]p. incl. illus. (AF 18(600)1587) Unclassified

Published in Rev. Scient. Instruments, v. 28: 574-575, July 1957.

The two techniques of multiple beam interferometry of metal surfaces and cinemography of the plastic deformation of metals, heretofore used individually, have

JHU.17:004, 005; JHU.18:002, 003

been coordinated in an effort to obtain information concerning the resolved rates of gliding during the slip process as a function of crystallographic orientation, strain rate, temperature, etc. The device used to join the techniques was the hydrocarbon, dibutyl phthalate, with which a half-silvered mirror could be coated without contaminating the silvered surface, and which possesses sufficiently high surface tension to hold the mirror in position. Using this technique, observations were made of the interference fringes developed, as well as the glide displacement which occurs as a function of time for a single slip line. Approximately 20 slip lines were shown to form within one specimen.

JHU.17:004

Johns Hopkins U. [Inst. for Cooperative Research]
Baltimore, Md.

SLIP VELOCITIES IN SEVERAL METALS AS MEASURED BY INTERFEROMETRIC CINEMICROGRAPHY, by R. B. Pond and E. [H.] Harrison. Aug. 1958, 61p. incl. diagrs. tables. (AFOSR-TR-58-96) (AF 18(600)1587) AD 162153; PB 138988 Unclassified

Velocities of edge dislocations propagation are measured and presented for (a) aluminum single crystals of varying orientation which have been extended at a constant rate; (b) aluminum single crystals of relatively constant orientation which have been extended at varying rates; and (c) α brass and copper single crystals of varying orientation which have been extended at constant rates. The difficulties of using the technique with Au, Ag, and β brass are presented and discussed. It is found that the velocity of edge dislocation propagation can be influenced by the juxtaposition in time and space of the slip line among its neighbors as well as by the rate of straining. These relationships are discussed. A reactivation of the slip plane after its first motion is more apparent in Cu and α brass than in aluminum. It is found also when slip is occurring there is no acceleration or deceleration during most of the interval--but the velocity of propagation is constant. (Contractor's abstract)

JHU.17:005

Johns Hopkins U. [Inst. for Cooperative Research]
Baltimore, Md.

GRAIN BOUNDARY MOVEMENT IN BICRYSTALLINE ALUMINUM, by R. B. Pond and E. [H.] Harrison. [1958] [12]p. incl. illus. diagrs. table, refs. (AF 18(600)1587) Unclassified

Presented at Thirty-ninth annual Convention of Amer. Soc. Metals, Chicago, Nov. 4-8, 1957.

Published in Trans. Amer. Soc. Metals, v. 50: 994-1005, 1958.

An investigation is reported of the plastic deformation of aluminum bicrystals having grain boundaries normal to the specimen axis. Data indicate that these "free" boundaries behave quite differently from boundaries which contain the specimen axis and are therefore influenced by a grip effect. A technique for producing transverse boundaries is described. Stress-strain diagrams for such specimens are given which show that the index of strain hardening for bicrystals whose boundaries are free to translate is lower in the plastic region than the index for single crystals of the parent orientation. Examination of both tension and compression specimens having the [121] pole in the slip plane and 90 degrees from the specimen axis shows that the boundary does translate during deformation causing the bicrystal to assume a "V" shape. In tensile specimens this translation is away from the acute angle made by the intersection of the slip planes in the two grains; in compression specimens, toward it. There is no significant bending of the slip planes at the grain boundary in either. (Contractor's abstract)

JHU.18:002

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

INTERFEROMETRIC SPECTROSCOPY (Abstract), by H. A. Gebbie, G. A. Vanasse, and J. Strong. [1956] [1]p. (AF 18(600)1307) Unclassified

Presented at meeting of the Opt. Soc. Amer., Philadelphia, Pa., Apr. 5-7, 1956.

Published in Jour. Opt. Soc. Amer., v. 46: 377, May 1956.

Interferometric spectroscopy in the far infrared has been used to study residual ray bands in crystals. New determinations of the wavelengths of the main peaks are of interest because of the use of some of these crystals for residual ray spectrometers. The value for cesium bromide, for example, is 119μ . The interferometer and system of analysis is discussed, as it is of general application as a method of spectroscopy in the far infrared.

JHU.18:003

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

INTERFEROMETRIC SPECTROSCOPY IN THE FAR INFRARED, by H. A. Gebbie and G. A. Vanasse. [1956] [1]p. incl. diagrs. (AF 18(600)1307) Unclassified

Published in Nature, v. 178: 432, Aug. 25, 1956.

Interferometric spectroscopy in the far infrared was used to study the resultant intensity from two interfering beams when the optical path-difference between them is

JHU. 18:004-006; JHU. 19:004

continuously changing. The spectrum observed was that from two caesium bromide crystal surfaces modified by the absorption spectrum of residual water vapor. The spectral data were interpreted in terms of the Fourier transform, which was obtained by numerical analysis, using a high-speed digital computer. The resolution shown was arbitrarily restricted by the numerical analysis and did not represent the limit imposed by the maximum path-difference between beams. The interferometer appeared to be readily adaptable to large construction to obtain greater light-grasp and resolving power. A larger instrument with aperture 30 cm has been made for study of atmospheric transmission in the submillimeter wave region.

JHU.18:004

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

INTERFEROMETRY IN THE FAR INFRARED (Abstract), by J. Strong. [1957] [1]p. [AF 18(600)1307]
Unclassified

Presented at Forty-first annual meeting of the Opt. Soc. Amer., Lake Placid, N. Y., Oct. 18-20, 1956.

Published in Jour. Opt. Soc. Amer., v. 47: 119, Jan. 1957.

Of the two projects at Johns Hopkins in which interferometry is applied to infrared spectroscopy, one applies multiple-beam interferometry and the other, two-beam interferometry. The advantages and limitations of these applications are discussed and the progress reviewed.

JHU.18:005

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

INTERFEROMETRIC SPECTROSCOPY IN THE FAR INFRARED, by J. Strong, H. A. Gebbie, and G. A. Vanasse. [1957] [4]p. incl. diagrs. (AF 18(600)1307)
Unclassified

The feasibility of using an interferometer spectroscope in the far infrared has been studied by examining the reflection spectrum from two CeBr crystal faces modified by the rotational spectrum of water vapor. A Fourier representation of part of the spectrum (from 60 to 120 cm^{-1}) has been given. A calculated water spectrum is presented for comparison.

JHU.18:006

Johns Hopkins U. [Lab. of Astrophysics and Physical Meteorology] Baltimore, Md.

[INTERFEROMETRIC MODULATION AND AN ANALOG COMPUTER FOR AN INTERFEROMETRIC SPECTROMETER] Modulation interférentielle et calculateur analogique pour un spectromètre interférentiel, by J. Strong and G. A. Vanasse. [1958] [5]p. incl. illus. [AF 18(600)1307] Unclassified

Presented at Internat'l. Colloquium on Recent Progress in Interferometric Spectroscopy, Paris (France), Sept. 9-13, 1957.

Published in Jour. Phys. et Radium (Paris), v. 19: 192-196, Mar. 1958.

The work on this project involving interferometric modulation for visible and far infrared spectroscopy is reviewed. Also, progress is reported on an analog computer that transforms the bolometric data directly into spectral intensities. A new interferometer, now under construction, is briefly described, particularly components of it that have been separately tested. (Contractor's abstract)

JHU.19:004

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

VIBRATION ROTATION BANDS OF AMMONIA. II. THE MOLECULAR DIMENSIONS AND HARMONIC FREQUENCIES OF NH_3 , by W. S. Benedict and E. K. Plyler.

July 1957 [16]p. incl. tables, refs. (AFOSR-TN-57-423) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1557 and Atomic Energy Commission) AD 136412 Unclassified

Also published in Canad. Jour. Phys., v. 35: 1235-1241, Oct. 1957.

A summary is given of molecular constants for NH_3 and ND_3 , as derived from high-resolution infrared spectra of a number of fundamental, overtone, and combination bands. Preliminary estimates are given for the equilibrium moments of inertia, the molecular dimensions, and the force constants of the harmonic potential function. The average molecular dimensions in the equilibrium configuration are $r_e = 1.011_4 \times 10^{-8}$ cm, $r_e = 0.380_2 \times 10^{-8}$ cm. (Contractor's abstract)

JHU.19:005 - JHU.19:008

JHU.19:005

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

COMMENTS ON THE SPECTRA OF TELLURIC H_2O AND CO_2 AS OBSERVED IN THE SOLAR SPECTRUM 2.8-23.7 MICRONS, by W. S. Benedict. [1957] [13]p. incl. tables, refs. (Bound with Liege U. (Belgium) Final technical rept. on Phase A (Part II); AD 210044) (AF 18(600)1557) Unclassified

Also published in Mém. Soc. Roy. Sci. Liège, Special v. 2: 18-30, 1957.

Wave lengths and wave numbers are given for the 3624 telluric and solar lines indicated in the Photometric Atlas of the solar spectrum from 2.8 to 23.7 μ . Identifications of 90% of these lines are made, and a discussion of the identifications according to the absorbing molecules and atoms is presented.

JHU.19:006

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

ROTATION-VIBRATION CONSTANTS OF AMMONIA (Abstract), by W. S. Benedict and E. K. Plyler. [1957] [1]p. (AF 18(600)1557) Unclassified

Presented at Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 10-14, 1957.

Published in Symposium on Molecular Structure and Spectroscopy. Abstracts, 1957, p. 34.

We have observed under high resolution the spectra of NH_3 and ND_3 between 1800-7100 cm^{-1} , and have analyzed 14 bands of the former and 9 bands of the latter species in that interval. The strongest combinations and overtones of the E vibrations are in general the perpendicular bands. Effective values of the rotation-vibration interaction constants and of ζ_3 and ζ_4 can be obtained from each analyzed band; these however show small variations in different combinations, so that it is difficult to obtain their limiting value at infinitesimal amplitude with a precision comparable to that of the measurements. One of the interactions responsible for this situation is the Fermi resonance between $2\nu_4^0$ and ν_1 , which is particularly marked in ND_3 ; another is the presence of the low potential barrier inversion. A table is included giving the best available values for the rotational constants in the ground state, their variation with vibration, and the resulting equilibrium dimensions.

JHU.19:007

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

TRANSMISSION FUNCTIONS FOR ATMOSPHERIC WATER VAPOR (Abstract), by W. S. Benedict. [1957] [1]p. (AF 18(600)1557) Unclassified

Presented at Forty-second annual meeting of the Opt. Soc. Amer., Columbus, Ohio, Oct. 17-19, 1957.

Published in Jour. Opt. Soc. Amer., v. 47: 1056, Nov. 1957.

An absolute calculation of atmospheric water vapor transmission in the pure rotation band has been made by summation of each line. Theoretical values were used for line positions, including weak isotopic lines, for rigid-rotator line strengths, and for Lorentz line widths. The transmission functions show pressure dependence and vary with spectral region. Over wide intervals they approach statistically calculated forms. Correlation with experimental data, especially Palmer's results from 20 to 40 μ , shows excellent agreement in form. Agreement in magnitude requires small increases in theoretical parameters, most probably resulting from positive deviations from Lorentz shape in the line wings.

JHU.19:008

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

VIBRATION-ROTATION BANDS OF AMMONIA. I. THE COMBINATION BANDS $\nu_2 + (\nu_1, \nu_3)$, by W. S.

Benedict, E. K. Plyler, and E. D. Tidwell. [1958] [25]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-1557 and Atomic Energy Commission) Unclassified

Published in Jour. Res. Nat'l. Bur. Standards, v. 61: 123-147, Sept. 1958.

A general discussion is given of methods used in the analysis of NH_3 vibration-rotation spectra, including the derivation of molecular constants and the determination of line strengths and line widths. Results are given for the region 2.15 to 2.48 μ (4,060 to 4,700 cm^{-1}), in which more than 800 lines have been measured. These have been analyzed into the inversion-doubled perpendicular combination band $\nu_2 + \nu_3$ ($\nu_0 = 4416.908$ and 4434.610 cm^{-1} ; band strength = 19.7 $cm^{-2} atm^{-1}$) and the inversion-doubled parallel combination band $\nu_1 + \nu_2$ ($\nu_0 = 4293.716$ and 4320.060 cm^{-1} ; band strength = 2.9 $cm^{-2} atm^{-1}$). Complete energy levels for these bands have been found up to $J = 12$ and 10, respectively, permitting determinations of molecular constants, which

JHU.19:009

include numerous higher-order effects involving the interaction of rotation, vibration, and inversion. The line widths range from a maximum of $0.57 \text{ cm}^{-1} \text{ atm}^{-1}$, when $K = J$ to a minimum of $< 0.2 \text{ cm}^{-1} \text{ atm}^{-1}$, when $K \ll J$. (Contractor's abstract)

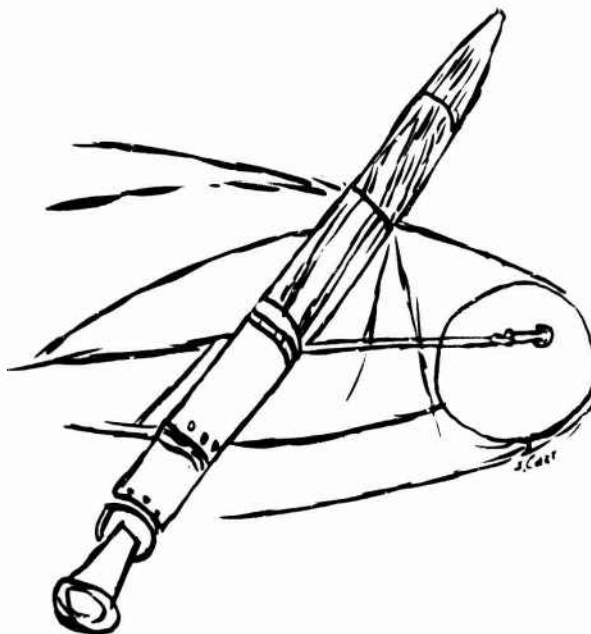
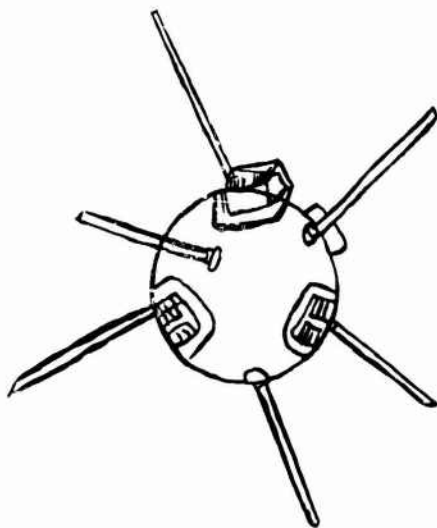
JHU.19:009

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

VIBRATION-ROTATION BANDS OF AMMONIA. III. THE REGION 3.2-4.3 MICRONS, by W. S. Benedict, E. K. Plyler, and E. D. Tidwell. [1958] [17]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1557 and Atomic Energy Commission) Unclassified

Published in Jour. Chem. Phys., v. 29: 829-845, Oct. 1958.

The weak absorption of NH_3 between $2373\text{-}3080 \text{ cm}^{-1}$ has been studied under high resolution, and a complete analysis given for over 1000 lines, including studies of the intensity and line width. The strongest bands ($S_v^0 = 0.44$ and $0.20 \text{ cm}^{-2} \text{ atm}^{-1}$, respectively) are $3\nu_2^s - 0^a$; and $3\nu_2^a - 0^s$; $\nu_3 - \nu_2$ ($S_v^0 = 0.074$); $\nu_3 + \nu_2 - 2\nu_2$ ($S_v^0 = 0.06$) have also been located. $\nu_2 + \nu_4$ shows anomalous intensity behavior as well as large vibration-rotation-inversion- ζ -splitting interactions. The lines in $3\nu_2$ are 40-50% narrower than those in the microwave region, and appear symmetrical with no pressure shifts. (Contractor's abstract)



KAR.01:002 - KAR.01:005

KAR.01:002

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

BIOPHYSICAL INVESTIGATIONS OF BONE TRANSPLANTS AND BONE IMPLANTS. AN EXPERIMENTAL STUDY, by K. Holmstrand. 1957, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-396) (AF 61(514)861) AD 132471 Unclassified

Also published in Acta Orthopaedica Scandinavica, Suppl. No. 26, p. 1-[91], 1957.

Biophysical techniques, including contact microradiography, x-ray diffraction techniques, the use of the ⁹⁰Sr polarizing microscope, and autoradiography with ⁹⁰Sr were utilized in the study of about 180 bone transplants and bone implants in a series of 56 rabbits and in two dogs. The bone transplants were fresh autogenous and homogenous cortical, fresh autogenous and homogenous cancellous. The implants were cooked bone, os purum, glycerol-ashed bone, and calcined bone. The biophysical methods are discussed from the standpoint of their application to (1) the study of the mineralization processes related to the healing and ultimate fate of different bone transplants; and (2) the study of the resorption rate of bone implants as influenced by their ultrastructural organization.

KAR.01:003

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

BIOPHYSICAL ANALYSES OF THE FORMATION AND STRUCTURE OF HUMAN FETAL BONE. A MICRO-RADIOGRAPHIC AND X-RAY CRYSTALLOGRAPHIC STUDY, by G. Wallgren. 1957, 80p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-397) (AF 61(514)861) AD 132472 Unclassified

Also published in Acta Paediatrica, Suppl. No. 113, p. 7-80, 1957.

Quantitative microradiography, x-ray diffraction, and polarization microscopy techniques were applied to human fetal bone in order to gain new information about mineral distribution and rate of mineral deposition as well as about the ultrastructure of rapidly growing bone and its relation to development. Observations revealed the following: (1) newly-formed bone possesses a very low degree of mineralization; (2) mineral content increases rapidly during the three weeks immediately following its first appearance, but thereafter maintains an almost constant level up to the time of birth; (3) parallel to the rapid increase in mineral content, there occurs a rapid increase in the long dimension of the apatite crystallites, which in newly-formed bone is very small; (4) between one and two weeks after the

crystallites form in fetal bone, they exhibit a distinct orientation in the long axis of the collagen fiber bundles; and (5) the rate of increase in mineral content appears to be a function of the rate of increase in crystallite size, while the ultimate level of mineralization attained in a given ultrastructural area of fetal bone is governed by those factors which cause crystallite growth to cease.

KAR.01:004

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

[RESEARCH ON THE PHYSIOLOGY OF BONE TISSUE], by A. Engström. Final rept. Mar. 25, 1958, 6p. (AFOSR-TR-57-96) (AF 61(514)861) AD 148009 Unclassified

The role of the skeleton in normal and diseased conditions has been investigated from the molecular to the anatomical level. To facilitate research several new analytical methods have been developed including x-ray crystallographic and x-ray microscopic techniques. The high biological reactivity of bone is partially clarified. It appears that areas of low mineralization found extensively in young bone have a high reactivity and thus are sites of ionic exchange. Bone salt is highly reactive due to a large surface area with specific charge patterns. This type of apatite structure is of great importance in the homeostasis of body ions. A careful recalculation of the permissible total body burden for ⁹⁰Sr has yielded a value of 0.1 μ c rather than 1 μ c. Procedures for preserving bone tissue in bone transplantation have also been devised.

KAR.01:005

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

DETERMINATION OF STRONTIUM AND CALCIUM IN BONE BY X-RAY ABSORPTIOMETRY, by A. Engström, C. Lagergren, and B. Lundberg. [1957] [7]p. incl. illus. diagrs. (AF 61(514)861) Unclassified

Published in Exper. Cell Research, v. 12: 592-598, June 1957.

The use of the x-ray diffractometer for the determination of Sr in the presence of Ca is described. The x-ray absorptiometric technique permits the determination of concentrations of Sr as small as a few tenths of a per cent. A method for microradiography with a dispersed, continuous spectrum covering the absorption edge has been developed and 10^{-6} - 10^{-8} of Ca can readily be determined. (Contractor's abstract)

KAR.01:006 - KAR.01:010

KAR.01:006

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

CONTACT MICRORADIOGRAPHY. A GENERAL SURVEY, by A. Engström. [1957] [10]p. incl. illus. diagrs. refs. (AF 61(514)861) Unclassified

Published in Proc. First Internat'l. Symposium on X-ray Microscopy and Microradiography, Cavendish Lab., Cambridge (Gt. Brit.) (Aug. 16-21, 1956), New York, Academic Press, 1957, p. 24-33.

The present status of contact microradiography is such that the resolution possible is that of the optimal resolution of a light microscope, i.e., about 0.2μ . A histochemical weighing technique is available which allows the estimation of the wet and dry mass of cellular structures as small as 10^{-12} to 10^{-14} gm with an error of 5-10%. The use of soft x-ray permits the quantitative histochemical analysis of certain biochemical elements in the cell such as P, S, and Ca with relatively good accuracy, while the use of ultra-soft x-rays should allow the extension of this technique to successful estimates of C, N, and O. Qualitative microradiography has found wide uses in studies of capillary circulation, mineral salt distribution, metallurgical research, and other fields. (Contractor's abstract, modified)

KAR.01:007

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

HIGH-RESOLUTION CONTACT MICRORADIOGRAPHY WITH ULTRASOFT POLYCHROMATIC X-RAYS, by A. Engström, R. C. Greulich and others. [1957] [16]p. incl. illus. diagrs. (AF 61(514)861) Unclassified

Published in Proc. First Internat'l. Symposium on X-ray Microscopy and Microradiography, Cavendish Lab., Cambridge (Gt. Brit.) (Aug. 16-21, 1956), New York, Academic Press, 1957, p. 218-233.

A review is presented of the practical methods which have been employed to achieve high-resolution microradiograms of biological samples using polychromatic x-radiation. A discussion is given of the effects of emulsion, system geometry, and x-ray production apparatus on the microradiograph resolution. Circuit and system construction as well as examples of microradiograms are presented.

KAR.01:008

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

CRYSTALLOGRAPHIC STUDIES OF CALCIUM AND

STRONTIUM HYDROXYAPATITES, by C. Lagergren and D. Carlström. [1957] [6]p. incl. diagrs. refs. (AF 61(514)861) Unclassified

Published in Acta Chemica Scandinavica, v. 11: 545-550, 1957.

From x-ray crystallographic investigations on apatites in the system $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2 - \text{Sr}_{10}(\text{PO}_4)_6(\text{OH})_2$ it was found that no solid solutions could be formed in the region $\text{Ca}_3\text{Sr}_7(\text{PO}_4)_6(\text{OH})_2$ to $\text{Ca}_7\text{Sr}_3(\text{PO}_4)_6(\text{OH})_2$. The mixed apatite $\text{Ca}_5\text{Sr}_5(\text{PO}_4)_6(\text{OH})_2$, however, was shown to have a very well ordered lattice. In the light of these experimental findings, it was concluded that Sr ions in the inorganic crystalline phase of bone are probably bound rather firmly to the surface of the extremely small apatite crystallites. (Contractor's abstract)

KAR.01:009

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

SUMMARY OF RECENT ADVANCES IN X-RAY MICRO-CHEMICAL TECHNIQUES, by A. Engström. [1957] [3]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under (AF 61(514)861), Swedish Medical Research Council, and Rockefeller Foundation) Unclassified

Published in [Metabolism of the Central Nervous System, London, Pergamon Press, 1957, p. 7-9].

Two types of x-ray microscopy are discussed. In contact microradiography the specimen is placed in close contact with a fine-grained photographic emulsion and exposed with soft x-rays. Mass resolution can be as small as $10^{14} - 10^{15} \text{ g}/\mu^2$. Accuracy is independent of specimen thickness since voltage can be selected. Projection and reflection microscopy has been aided by the development of the point focus x-ray source. Two types of x-ray diffraction are also discussed. Soft radiation, i.e. Al K α or Cu L α radiation, yields good intensity of scattered radiation from thin samples. Microdiffraction cameras are being developed.

KAR.01:010

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

HIGH RESOLUTION MICRORADIOGRAPHY WITH ULTRASOFT X-RAYS, by A. Engström, B. Lundberg, and G. Bergendahl. [1958] [11]p. incl. illus. diagrs. (AFOSR-TN-58-425) (AF 61(514)861; continued by AF 61(052)15) AD 158228 Unclassified

KAR.02:001-003; KAR.03:001;
KAR.04:001

Also published in Jour. Ultrastructure Research, v. 1: 147-157, Dec. 1957.

A small compact microradiographic unit for micro-radiography with ultrasoft x-ray has been developed. The equipment is simple in operation and yields microradiograms with a linear resolution of about 0.25 microns. The microradiograms recorded with soft and ultrasoft x-rays will show the distribution of dry weight in soft biological material, and also the distribution of water. The procedure of quantitative microradiography gives the possibility of obtaining accurate information about the parameters mentioned, and with an analytical error of only a few to ten per cent. (Contractor's abstract)

KAR.02:001

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

BONE AND RADIOSTRONTIUM, by A. Engström, R. Björnerstedt and others. New York, Wiley and Sons, 1957, 139p. incl. illus. diags. tables, refs. [AF 61(052)15, continuation of AF 61(514)861]

Unclassified

Recent work performed at Karolinska Institute on the physiology and structure of the skeleton is reviewed with special attention given to the accumulation of radioactive strontium. This survey begins with a summarized general introduction regarding the metabolism of strontium. Two chapters then follow on the distribution of mineral salts in the skeleton and the molecular structure of the inorganic phase in bone. Actual experiments performed with radioactive strontium in animals are reported in Chapter IV. On the basis of the biological data obtained, calculations regarding the dose rates from the captured radiostrontium are presented in Chapter V. A discussion summarizes the data in chapters II, III, IV, and V and deduces from them values for the permissible total body burden of radioactive strontium in human beings.

KAR.02:002

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

NOTE ON THE DISTRIBUTION OF MINERAL SALTS AND "BONE SEEKING" RADIOISOTOPES IN SPONGIOUS BONE TISSUE, by A. Engström and G. Bergendahl. [1958] [4]p. incl. illus. (AF 61(052)15) AD 231683

Unclassified

Published in Exper. Cell Research, v. 15: 265-268, Aug. 1958.

The bone lamellae in spongy bone have a high uptake of radioisotopes (dried powder of spongy bone has at

least twice the radioactivity of powdered compact bone) depending upon the greater number of reactive sites per unit volume in comparison with that of compact bone. This non-uniform distribution of radioisotopes within the bone lamellae has been used for the calculation of the local, internal dose rates given by ^{90}Sr with the purpose of stating limits for total body burden, e.g., in connection with the fall-out problem.

KAR.02:003

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

THE PROJECTION X-RAY MICROSCOPE FOR DIVERGENT-BEAM DIFFRACTION, by D. Carlström and B. Lundberg. [1958] [8]p. incl. diags. (AF 61(052)15)

Unclassified

Published in Jour. Ultrastructure Research, v. 2: 261-288, Dec. 1958.

The projection x-ray microscope is a suitable instrument for divergent-beam diffraction. Monochromatization of the radiation improves the diffraction patterns and increases the possibilities of the divergent-beam method. The use of photographic emulsions with extremely high resolution facilitates the recording of the diffraction patterns. (Contractor's abstract)

KAR.03:001

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

PUBLICATIONS ISSUED FROM THE DEPARTMENT OF MEDICAL PHYSICS, by A. Engström. Jan. 31, 1958, 15p. (List no. 1) (AFOSR-TN-58-465) [AF 61(052)21] AD 158272

Unclassified

This is a complete bibliography of the publications issued by the Department of Medical Physics. It includes 209 items dated from 1943 through 1957. Subsequent lists are to be published annually.

KAR.04:001

Karolinska Inst. Nobel Inst. for Neurophysiology, Stockholm (Sweden).

THE INFLUENCE OF HYPOTHALAMIC THERMOCEPTIVE STRUCTURES ON THE ELECTROENCEPHALOGRAPH AND GAMMA MOTOR ACTIVITY, by C. von Euler and U. Söderberg. [1957] [18]p. incl. diags. refs. (AF 61(514)1083)

Unclassified

Published in EEG Clin. Neurophysiol., v. 9: 391-408, Aug. 1957.

KAR.04:002 - KAR.04:004

It is shown that the effects of hypothalamic heating are mediated by common relays influencing both gamma motor and cortical activity. Hypothalamic thermoreceptive structures may, thus like most peripheral receptors, project upon the activating relay system of the brain stem. The muscle spindle test has been found to be a useful index of that system. The significance of the results for homeostasis of body temperature is discussed.

KAR.04:002

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

THE RELATION BETWEEN ACTIVITY AND BLOOD FLOW IN THE THYROID GLAND, by U. Söderberg. [1958] [3]p. incl. diagrs. refs. (AFOSR-TN-58-319) (AF 61(514)1083) Unclassified

Also published in *Experientia*, v. 14: 229-231, 1958.

Experiments are presented of the relation between thyroid activity and thyroid blood flow. A better understanding of the regulation of the thyroid functions has been made possible by using the uptake of iodine in the gland. Experiments were performed on 18 cats and 66 rabbits under light to moderate anaesthesia, and the animals were completely heparinized. Results of the experiments showed the following: (1) the rate of uptake of iodine was largely proportional to the blood flow through the gland, (2) the uptake was somewhat augmented when the animals were breathing pure oxygen and decreased during inhalation of gas mixtures rich in CO₂ or poor in O₂, (3) the turnover rate of iodine

within the gland was generally reduced, probably by influence of the anesthetics, (4) the rate of secretion of thyroid hormone, in contrast to the rate of uptake of inorganic iodide, was found to follow what was believed to be the titre of endogenous thyrotropic hormones (TSH) or administered exogenous TSH regardless of the blood circulation through the gland, (5) adrenaline injected intravenously had inconstant effects, (6) the rate of uptake of iodine and rate of release of thyroid hormone may be widely independent of each other, (7) changes in thyroid activities may be more rapid than was expected and thyroid activities may be a useful index of vegetative changes both in physiological and pharmacological experiments even in animals subjected to small operations under anesthesia, (8) nervous and hormonal stimuli have been shown to have marked effects on thyroid hormone secretion, however, these effects are due to changes in the responsiveness to TSH and cannot be demonstrated in the absence of the pituitary hormone.

KAR.04:003

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

SHORT TERM REACTIONS IN THE THYROID GLAND, by U. Söderberg. [1958] [113]p. incl. illus. diagrs. refs. (AFOSR-TN-58-426) (AF 61(514)1083) AD 158229 Unclassified

Also published in *Acta Physiologica Scandinavica*, v. 42: Suppl. 147, 1958.

The purpose of the investigation was to devise a method which would permit a continuous measure of the arterio-venous concentration difference both of iodide and of thyroid hormones, and to study briefly some nervous and hormonal influences on thyroid activity. Flow rates and radioactive iodine (¹³¹I and ¹³²I) concentrations of blood entering and leaving the thyroid gland were measured. The technique was employed in 19 cats and 66 rabbits. The thyroid was dissected free of its surroundings, its largest vein was cannulated and the others ligated. Each drop of blood which issued from the cannula was counted and fell on a moving strip of filter paper. The interval between the appearance of successive drops was measured and recorded by an electric ordinate writer. The drops on the filter paper were dried and then individually analyzed for radiiodine. A similar analysis of arterial blood was made. This provided the simultaneous descriptions of blood flow and arteriovenous concentration differences, and these two factors then permitted the calculation of the rate of uptake of iodine and the rate of secretion of hormonal iodine. The validity of the technique and the physiological significance of the results are discussed. The results show that it is possible to record the thyroid arterio-venous iodine concentration difference and blood flow continuously for several hours with a high degree of accuracy and good temporal resolution. This technique has revealed, and permitted the measurement of changes in activity which are both rapid and frequent and so provides a useful index of vegetative activity in experimental animals.

KAR.04:004

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

CO-ORDINATED CHANGES IN TEMPERATURE THRESHOLDS FOR THERMOREGULATORY REFLEXES, by C. von Euler and U. Söderberg. [1958] [18]p. incl. illus. diagrs. refs. (AFOSR-TN-58-793) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1083 and Swedish Medical Research Council) AD 203226 Unclassified

Also published in *Acta Physiologica Scandinavica*, v. 42: 1:2-129, 1958.

KSU. 01:001-003; KEN. 01:001

Hypothalamic temperature levels have been studied to determine whether changes in body temperature are the result of some regulatory mechanism. At these levels several heat-dissipating, heat-preserving and heat-producing reflexes appear and they cause shifts to new temperatures. Co-ordinated changes in the threshold temperatures for these thermoregulatory reflexes have been elicited in response to different stimuli. Stimuli which activate the electroencephalogram and the gamma motor system tend to raise the temperatures. Stimuli which deactivate the gamma motor system and evoke synchronized cortical activity tend to lower threshold temperatures. Body temperature changes correspondingly. The results indicate that body temperature is set at different levels in different states of activity.

KSU.01:001

Kent State U. Dept. of Physics, Ohio.

ON DAS' THEORY OF NUCLEAR MAGNETIC RESONANCE IN SOLIDS, by J. W. McGrath and A. A. Silvidi. Mar. 24, 1958 [3]p. incl. diagrs. (AFOSR-TN-58-245) (AF 49(638)168) AD 154147 Unclassified

Also published in Jour. Chem. Phys., v. 29: 103-105, July 1958.

Das' theory developed the effect of vibratory rotary motion of water molecules in crystalline hydrates on the resonance spectra of the protons. Limitations on applicability of his theory are discussed. The theory is extended to the general case and a further effect on spectra is obtained. This effect is dependent upon the orientation of the proton-proton axis within the crystal, the orientation of the crystal in the magnetic field, the temperature and the height of the twofold potential barrier containing the water molecule. Partial experimental support of the theory is cited. Two methods for measuring proton-proton separations that do not require Das' theory corrections are described. A method for measuring the height of the potential barrier is described.

KSU.01:002

Kent State U. [Dept. of Physics] Ohio.

PROTON MAGNETIC RESONANCE IN HYDRATED SINGLE CRYSTALS (Abstract), by J. W. McGrath, A. A. Silvidi, and J. C. Carroli. [1958] [1]p. [AF 49(638)-168] Unclassified

Presented at meeting of the Ohio Section of the Amer. Phys. Soc., Akron, Ohio, Apr. 11-12, 1958.

Published in Bul. Amer. Phys. Soc., Series II, v. 3: 349, Aug. 26, 1958.

The proton-proton separations in a series of hydrated crystals are being remeasured since reported values vary by more than experimental error. If this variation is real, an explanation will be sought. A slightly modified Pound-Watkins NMR spectrometer is being used. Parameters are: rf = 25 mc, H = 5870 gauss, modulation amplitude = 1 gauss, modulation frequency = 280 cps and sweep speed = 0.02 gauss/sec. Signal to noise ratios for crystals are about 30. The Pake technique is being used. For gypsum the measured value of the p-p separation is $1.58 \pm 0.02\text{\AA}$. The p-p axes lie in the ab plane ($\pm 10^\circ$) and they make angles of $36 \pm 4^\circ$ and $45 \pm 4^\circ$ with the axis. These values agree well with those of Pake. In lithium sulfate, an orientation-independent shift of +3 gauss appears in the Pake curve. This is essentially in agreement with Pake. The origin and effects of this shift are being studied.

KSU.01:003

Kent State U. [Dept. of Physics] Ohio.

SPIN-LATTICE RELAXATION TIMES IN LIQUIDS (Abstract), by F. D. Adams and A. A. Silvidi. [1958] [1]p. [AF 49(638)168] Unclassified

Presented at meeting of the Ohio Section of the Amer. Phys. Soc., Granville, Ohio, Oct. 17-18, 1958.

Published in Bul. Amer. Phys. Soc., Series II, v. 3: 427, Dec. 29, 1958.

Proton spin-lattice relaxation times T_1 are being measured in liquids using a NMR spectrometer. The direct method of measurement is being used. Parameters are: rf frequency - 25 mc, field H - 5870 gauss, modulation amplitude - 1 gauss, and modulation frequency - 260 cps. For water (dissolved oxygen - 0.0057 cc/g standard pressure and temperature 26°C) the measured value of T_1 is 2.8 ± 0.1 sec. For diethyl ether T_1 is 3.5 ± 0.3 sec. These measurements agree with those made by Bloembergen, Purcell, and Pound. Spin-lattice relaxation times are being measured for other liquids.

KEN.01:001

Kentucky U. [Dept. of Chemistry] Lexington.

SELECTIVE CLEMMENSEN REDUCTION OF 1,2-DIKETONES (Abstract), by W. T. Smith, Jr. [1957] [1]p. [AF 49(638)49] Unclassified

Presented at meeting of the Sixteenth Internat'l. Congress of Pure and Appl. Chem., Paris (France), July 13-24, 1957.

Published in Résumés des Communications, v. 2: 151, July 1957.

KEN.01:002, 003; KEN.02:001

The Clemmensen reduction of 2,3-pentanedione, 2,5-octanedione, diosphenol, and camphorquinone has been studied. In the cases of the first three compounds mentioned, it is possible to reduce one carbonyl group without reduction of the other. The reduction of 2,3-pentanedione and diosphenol gives a mixture of the two possible isomeric monoketones. 2,3-octanedione is reduced selectively to 2-octanone. Camphorquinone is reduced to a mixture of hydroxycamphor and hydroxyepicamphor. This mixture is not reduced further to the monoketones. A mechanism is advanced to explain both the results with camphorquinone and the reduction of the apparently more hindered carbonyl group of 2,3-octanedione. This explanation is based on two considerations. The first of these is the probable conformations of 1,2-dicarbonyl systems in acyclic and in five and six-membered ring diketones. The second consideration is that when conjugation is possible between the 1,2-dicarbonyl groups, the point of attachment of the diketone to the zinc will be at the oxygen rather than at the carbon.

INFLUENCE OF STRUCTURE AND SOLVENT, by W. T. Smith, Jr., D. Trimnell, and L. L. Grinninger. Oct. 1958, 6p. (AFOSR-TN-58-899) (AF 49(638)49) AD 204231 Unclassified

Presented at meeting of the Amer. Chem. Soc., Chicago, Ill., Sept. 10, 1958.

Also published in Jour. Org. Chem., v. 24: 664-666, May 1959.

The UV absorption spectra of aliphatic and aromatic N-sulfinyl amines in ether and alcohol were investigated. The spectra of both 2,4- and 2,6-dimethyl-N-sulfinylaniline were compared to obtain evidence that the band at 314 to 330 mμ is due to the conjugation of the NSO group. Molecular models show that considerable interference will occur between the NSO group and the methyl groups in the ortho position. Comparing the spectral data showed that the interference caused by the 2 o-methyl groups has a pronounced effect on the spectra. The data indicated that the longer wavelength band is due to the over-all system consisting of the aromatic ring and the NSO group. The shift of the maxima to longer wavelengths appears to be related to the methyl substituents. Unsubstituted N-sulfinylaniline has a maximum at 314 mμ; introducing a methyl group in the 4 position shifts the maximum to 328 mμ. A 2-methyl substituent shifts the maximum to 322 mμ. In 2,4-dimethyl N-sulfinylaniline, the shift is 23 mμ. A slight steric effect of a single o-methyl group was indicated by a decrease of log ε from 4.00 in N-sulfinylaniline to 3.98 in 2-methylaniline; the decrease is significant because a methyl group in the para position increased the log ε to 4.10. N-Sulfinylaniline showed no reaction with allyl alcohol, ethylene glycol, isopropyl alcohol, tert-butyl alcohol, benzyl alcohol, and triethyl carbinol; however, it reacted with the more acidic alcohols. p-Nitro-N-sulfinylaniline reacted with methyl, ethyl, propyl, isopropyl, butyl, and tert-butyl alcohols.

KEN.01:002

Kentucky U. Dept. of Chemistry, Lexington.

N-SULFINYL AMINES. REACTIONS WITH CARBOXYLIC ACIDS, by W. T. Smith, Jr. and G. G. King. Apr. 1958, 7p. (AFOSR-TN-58-258) (AF 49(638)49) AF 154162 Unclassified

Also published in Jour. Org. Chem., v. 24: 976-978, July 1959.

Refluxing a solution of N-sulfinylaniline in acetic acid showed no evolution of SO₂, and no acetanilide could be isolated from the solution; unsuccessful results were obtained with other acids. Tests were conducted to show the catalytic effect of both thionyl chloride and HCl on the N-sulfinylaniline-acetic acid reaction. The catalytic effect of thionyl chloride appears to be due to the fact that it does not yield HCl under the conditions used in the reaction. Anilides of the following acids were obtained by refluxing the acid with N-sulfinylaniline and a drop of thionyl chloride: formic acid, 44% yield; benzoic acid, 30% yield; chloroacetic acid, 65% yield; and glutaric acid, a trace of dianilide. These reactions are not peculiar to N-sulfinylaniline. The N-sulfinyl derivatives of p-nitroaniline and cyclohexylamine are converted to the corresponding N-acetyl derivatives by refluxing in acetic acid containing a trace of thionyl chloride. The reaction of p-nitro-N-sulfinylaniline with acetic acid gives a 92% yield of p-nitroacetanilide.

KEN.02:001

Kentucky U. [Dept. of Physics] Lexington.

ELECTRICAL PROPERTIES OF ARSENIC-ANTIMONY SELENIDES (Abstract), by D. F. Clifton and L. Gildart. [1957] [1]p. [AF 49(638)90] Unclassified

Presented at meeting of the Amer. Phys. Soc., Notre Dame U., South Bend, Ind., June 20-22, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 281, June 20, 1957.

Certain mixtures of As₂Se₃ and Sb₂Se₃ readily solidify in the vitreous state, as shown by x-ray diffraction. These vitreous specimens behave as semiconductors with wide energy gap.

KEN.01:003

Kentucky U. Dept. of Chemistry, Lexington.

ULTRAVIOLET SPECTRA OF N-SULFINYL AMINES.

KEN.02:002 - KEN.02:005

KEN.02:002

Kentucky U. [Dept. of Physics] Lexington.

ELECTRICAL AND OTHER PHYSICAL PROPERTIES OF SOME VITREOUS SELENIDES (Abstract), by D. F. Clifton and L. Gildart. [1957] [1]p. [AF 49(638)90]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Boulder, Colo., Sept. 5-7, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 301, Sept. 5, 1957.

Properties of the vitreous form of compounds of the Group Vb and Group VIB elements of the type A_2B_3 (mainly selenides) have been studied. The absence of small angle x-ray scattering shows the materials to be truly vitreous rather than microcrystalline. Structure semiconducting behavior, tendency toward crystallization, softening temperature, and density are the properties considered.

KEN.02:003

Kentucky U. [Dept. of Physics] Lexington.

SELENIDES PROJECT, by L. Gildart and D. F. Clifton. Progress rept. no. 1, July 31, 1958 [86]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-849) [AF 49(638)90] AD 203361; PB 138436 Unclassified

An investigation was initiated into the general field of the electrical, liquid-solid transformation properties of systems of the group Va and VIA elements As, Sb, Bi, O, S, Se, and Te. Vitreous films of Sb_2S_3 were prepared on glass substrates by evaporation in vacuo with compositions ranging from about 46.9 to 51.8 wt-% Se. These were readily devitrified (crystallized) by moderate heat treatment, permitting direct comparison between properties of the vitreous and crystalline forms of the same sample. Semiconductivity was exhibited by both vitreous and crystalline Sb_2Se_3 films. The

vitreous films had an activation energy of 1.83 ± 0.14 ev, and the crystalline films had an activation energy of 1.07 ± 0.08 ev. The equal power spectral response for the region 4500 to 7000 Å is essentially flat for both types of film. A new semiconductor resistivity phenomenon, a switching effect, is described as follows: when a slowly increasing electric field is applied to a sample of stibnite, containing excess Sb, there is a sudden large drop in resistance, or an electrical breakdown, at a critical value of the field. The new low value of resistance is retained indefinitely at room temperature, but the resistance can be restored to the original high value at any time the sample is momentarily heated to 100° to 300°C. The cycle can be repeated at will. The duration of the breakdown is about 2 μsec, and the re-

sistance recovery at about 205°C is also abrupt. Liquid-solid transformation and structure studies were made on As_2S_3 , As_2Se_3 , As_2Te_3 , Sb_2S_3 , Sb_2Se_3 , Sb_2Te_3 , Bi_2S_3 , Bi_2Se_3 , and Bi_2Te_3 . (ASTIA abstract)

KEN.02:004

Kentucky U. [Dept. of Physics] Lexington.

REVERSIBLE LOW-VOLTAGE BREAKDOWN IN STIBNITE (Abstract), by J. R. Davis and L. Gildart. [1958] [1]p. [AF 49(638)90] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 218, May 1, 1958.

Electric breakdown has been found to occur in both single-crystal and polycrystalline rods of stibnite containing up to 2.5% excess antimony at field strengths from 50 to 1000 volts/cm. This compares with breakdown fields in most insulators of the order of 10^6 volts/cm. The breakdown in stibnite establishes an electrically traceable low-resistance path through the material which at room temperatures is essentially permanent but which is rapidly annealed out when the sample is heated to about 300°C. After the temperature cycle the sample is apparently restored to its original state. In these samples the breakdown time is less than one microsecond and the resistance decreases from about 10^{10} ohms to about 10^4 ohms. Prebreakdown pulses are observed like those reported by McKay in silicon p-n junctions. Breakdown has also been produced in devitrified thin films of stibnite, but the fields required are much greater and the resistance change less pronounced.

KEN.02:005

Kentucky U. [Dept. of Physics] Lexington.

VITREOUS AND CRYSTALLINE SEMICONDUCTING FILMS OF Sb_2Se_3 (Abstract), by T. E. Johnson and L. Gildart. [1958] [1]p. [AF 49(638)90] Unclassified

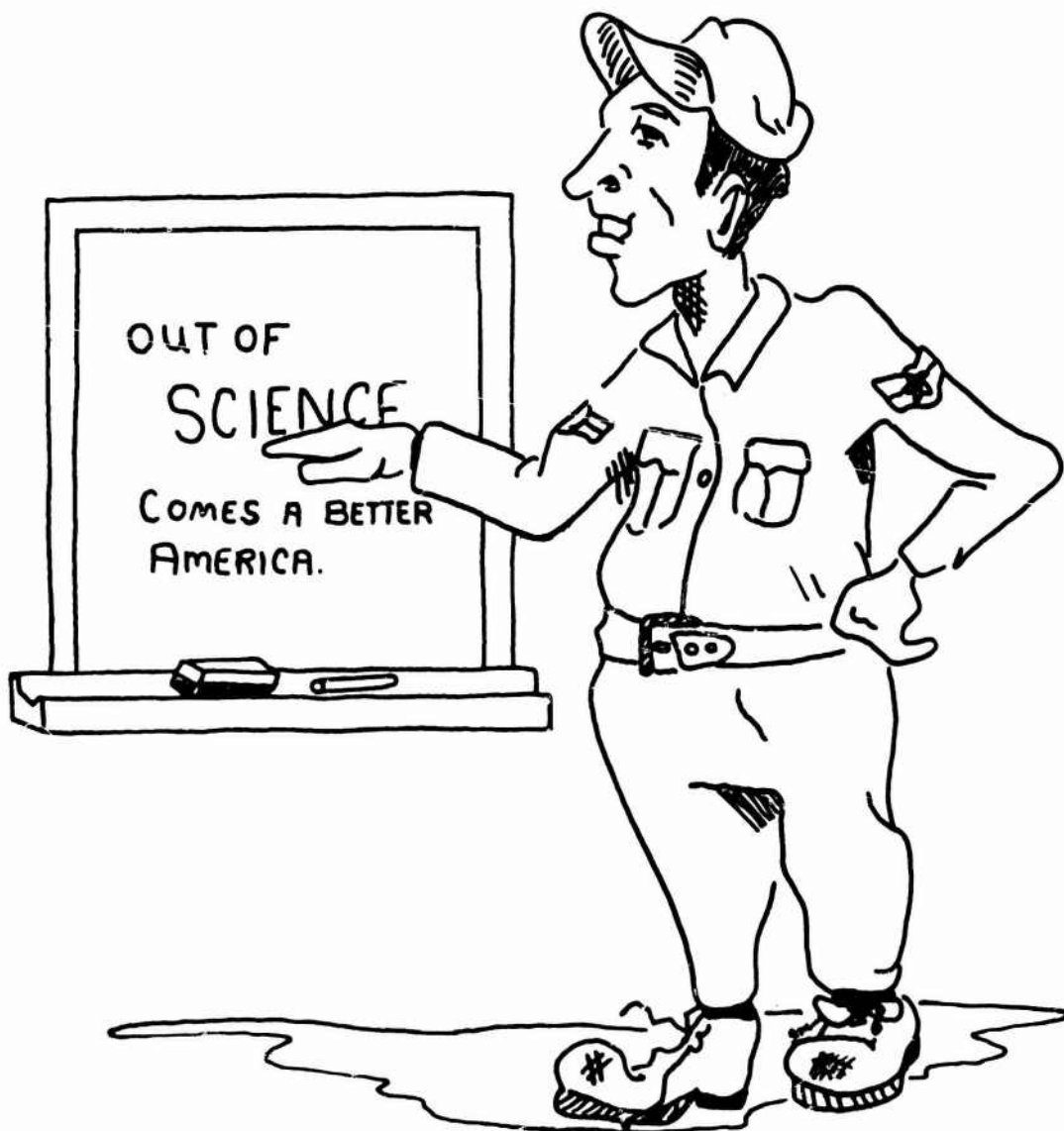
Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 232, May 1, 1958.

Vitreous films of antimony triselenide, ordinarily a crystalline semiconductor in the bulk, have been prepared by vacuum evaporation on Pyrex. When heated from room temperature to about 250°C they show an initial (irreversible) activation energy of 1.8 ev, but

after a short while the films devitrify to a polycrystalline form with an activation energy of 1.1 ev (reversible). The large resistivity discontinuity produced in bulk Sb_2Se_3 by addition of 0.1% excess selenium was not found in the films, either in the vitreous or the crystalline form. The vitreous films had resistivities of the order of 10^7 ohm-cm at room temperature, and the

devitrified films of the order of 10^4 ohm-cm, and neither showed any appreciable variation of resistivity vs composition. Both forms showed moderate photoresponse in the visible, surprisingly flat from about 5000A to beyond 7500A. All films were of the order of $200 \mu\text{g}/\text{cm}^2$ in thickness; upon devitrification there was an apparent shrinkage revealed by fissuring in some case, indicating a density increase of about 5%.



LAV.01:016 - LAV.01:020

Laboratoire Méditerranéen de Recherches Thermodynamiques, Nice (France). see Méditerranéen de Recherches Thermodynamiques, Nice (France).

LAV.01:016

Laval U. Dept. of Chemistry, Quebec (Canada).

INHIBITION BY HYDROGEN PEROXIDE OF THE SECOND EXPLOSION LIMIT OF THE HYDROGEN-OXYGEN REACTION, by W. Forst and P. A. Giguère. Oct. 28, 1957 [16]p. incl. diagrs. refs. (AFOSR-TN-57-711) (AF 18(600)492) AD 136705 Unclassified

Also published in Jour. Phys. Chem., v. 62: 340-343, Mar. 1958.

The inhibiting action of hydrogen peroxide on the upper limit of the H-O reaction has been studied at 447°C by the withdrawal technique as a function of the composition of the mixtures. The pressure ratio of the inhibited limit to the normal 2nd limit showed a quadratic dependence on the peroxide concentration. The simplest scheme to account for the results is to add the two reactions $H_2O_2 + H \rightarrow H_2O + OH$ and $H_2O_2 + OH \rightarrow H_2O + HO_2$ to the generally accepted mechanism for the second limit.

LAV.01:017

Laval U. [Dept. of Chemistry] Quebec (Canada).

INHIBITION BY HYDROGEN PEROXIDE OF THE SECOND EXPLOSION LIMIT IN HYDROGEN-OXYGEN MIXTURES, by P. A. Giguère and I. D. Liu. [1957] [2]p. (AF 18(600)492) Unclassified

Presented at meeting of the Chemical Inst. of Canada, Montreal, May 28-31, 1956.

Published in Jour. Amer. Chem. Soc., v. 79: 5073-5074, Sept. 23, 1957.

The partially homogeneous character of the gas-phase decomposition of H_2O_2 above 400° was confirmed. When H, O, NO, and other gases were added to study their effect on the rate of decomposition, only H showed any effect; the reaction was markedly accelerated at 440-70° at total pressures in excess of 20 mm. At lower pressures the H reacted explosively with the O from the decomposition of the H_2O_2 , but the explosions occurred only after all or nearly all of the H_2O_2 had disappeared, although the mixtures were within the explosion range. H_2O_2 was found to be approximately 10 times as effective in inhibiting explosions as is H_2O .

LAV.01:018

Laval U. Dept. of Chemistry, Quebec (Canada).

[INFRARED ABSORPTION SPECTRUM OF NITROUS OXIDE IN THE SOLID STATE] Spectre d'absorption infra-rouge du protoxyde d'azote, by P. A. Giguère and K. B. Harvey. [1957] [4]p. incl. diagr. tables, refs. (AF 18(600)492) Unclassified

Published in Spectrochimica Acta, v. 9: 204-207, 1957.

The infrared spectrum of solid N_2O at -175° was measured in the range 2 to 25 μ . In addition to the 3 fundamentals, 4 overtones, and 6 combinations were observed. Four very weak bands are assigned to the isotopic molecules $N^{14}N^{15}O$ and $N^{15}N^{14}O$. Certain features of the spectrum may be due to some disorder in the crystal.

LAV.01:019

Laval U. [Dept. of Chemistry] Quebec (Canada).

SECOND-ORDER UNIMOLECULAR KINETICS IN THE THERMAL DECOMPOSITION OF HYDROGEN PEROXIDE VAPOR, by W. Forst and P. A. Giguère. June 27, 1958 [27]p. incl. diagrs. tables, refs. (AFOSR-TN-58-587) (AF 18(600)492) AD 162110 Unclassified

Also published in Canad. Jour. Chem., v. 36: 1308-1319, Sept. 1958.

The thermal decomposition of hydrogen peroxide vapor has been re-investigated by the static method as a function of initial pressure at pressures up to 22 mm Hg, and in the presence of inert gas (helium, oxygen and water) up to 100 mm Hg. In each case the apparent first-order rate constant increased linearly with pressure. It is demonstrated that under the present experimental conditions the pyrolysis of hydrogen peroxide shows behavior typical of an elementary unimolecular reaction in its low-pressure second-order region. The reaction was accompanied by a heterogeneous decomposition which in the presence of foreign gas became inhibited. Helium was used as inhibitor over the temperature range 430-470°C, which permitted calculating the activation energy for activation with peroxide and with helium. The results can be satisfactorily accounted for by assuming a critical energy of 47-50 kcal and 5 effective classical oscillators for activation with peroxide and 3 with helium, provided deactivation occurs on every collision. Kinetic evidence against this assumption is briefly discussed. (Contractor's abstract)

LAV.01:020

Laval U. Dept. of Chemistry, Quebec (Canada).

EVIDENCE FOR OXYGEN INTERMEDIATES IN GASES,

LAV. 01:021; LAV. 02:001;
LEH. 02:001, 002

LIQUIDS, AND SOLIDS, by P. A. Giguère and J. A. Herman. [1958] [15]p. incl. diagr. refs. (AFOSR-TN-58-794) (AF 18(600)492) AD 202227 Unclassified

Presented at Internat'l. Congress of Radiation Research, Burlington, Vt., Aug. 11-15, 1958.

Also published in Radiation Research, Suppl. v. 1: 149-163, 1959.

A survey is presented of studies of oxygen intermediates based on direct physical evidence. The subject is narrowed down to the simplest intermediates, oxygen atoms, $\cdot\text{OH}$ and $\text{HO}_2\cdot$ radicals, and possibly a few others.

It is mentioned that the positive identification of a free radical in a given process may lead to elucidation of part or all of the mechanism involved. The difficulties, however, are considerable; of the various physical methods used so far to detect free radicals, only a few can yield detailed information on the nature of the species, their structure, etc.

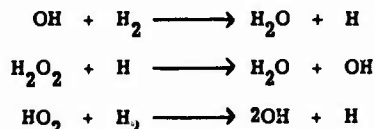
LAV.01:021

Laval U. [Dept. of Chemistry] Quebec (Canada).

KINETICS OF THE THERMAL REACTION OF HYDROGEN PEROXIDE WITH HYDROGEN, by W. Forst. Nov. 25, 1958 [21]p. incl. diagrs. refs. (AFOSR-TN-58-1070) (AF 18(600)492) AD 207230; PB 138351 Unclassified

Also published in Canad. Jour. Chem., v. 37: 1616-1620, Sept. 1959.

The reaction proceeds with a pressure increase at constant volume and is thus accessible to study by the static method. At the pressures used the rate of activation is rate-determining in the unimolecular decomposition of hydrogen peroxide. When experimental results are corrected for activation by hydrogen, the reaction is found to be first order in both hydrogen and peroxide. A simple mechanism consistent with experimental results consists of the reactions postulated in the decomposition of hydrogen peroxide, plus the reactions



Experimental evidence points to a low value for rate constant k_3 . The significance of these results is briefly discussed in connection with the kinetics of the nitric oxide-hydrogen reaction. (Contractor's abstract)

LAV.02:001

Laval U. [Dept. of Physics] Quebec (Canada).

SPECTRUM OF L AUGER ELECTRONS FROM $^{208}_{81}\text{Tl}$ AND $^{212}_{83}\text{Bi}$, by C. Geoffrion and G. Nadeau. July 1, 1957 [14]p. incl. diagr. tables. (AFOSR-TN-57-607) (AF 18(600)1574) AD 136643 Unclassified

Also published in Canad. Jour. Phys., v. 35: 1284-1291, Nov. 1957.

The spectrum of L Auger electrons emitted by a source of $\text{Th}(\text{B+C}''')$ has been measured with a 180° beta-ray spectrometer. An empirical formula for the calculation of secondary ionization potentials has been used for a tentative identification of the transitions giving rise to the measured lines. (Contractor's abstract)

LEH.02:001

Lehigh U. [Dept. of Mathematics] Bethlehem, Pa.

SOME GLOBAL THEOREMS ON HYPERSURFACES, by C.-C. Hsiung. [1957] [10]p. [AF 49(638)215] Unclassified

Published in Canad. Jour. Math., v. 9: 5-14, 1957.

The following theorem is established which Hopf and Voss obtained for $n = 2$ [Arch. Math., v. 3: 187-192]: Let V_n, V_n^* be two orientable hypersurfaces twice differentially imbedded in a Euclidean space E_{n+1} ($n + 1 = 3$). Suppose that there is a differentiable homeomorphism between V_n, V_n^* such that the orientations are preserved and the line joining every pair of corresponding points P, P^* is parallel to a fixed direction given by the unit vector I , and such that V_n, V_n^* have equal first mean curvatures M_1, M_1^* at every pair of the points P, P^* but no cylindrical elements whose generators are parallel to the fixed direction I . Then V_n, V_n^* can be transformed into each other by a translation. The proof is based on the integral formula

$$n \int V_n w (M_1^* - M_1) I \cdot N dA + \int V_n (1 - N \cdot N^*) (dA + dA^*) = 0,$$

where w is the distance PP^* ; N, N^* the unit normal vectors at P, P^* and dA, dA^* the area elements. From this theorem, other results of Hopf and Voss (paper quoted above) are also extended to $n > 2$. (Math. Rev. abstract)

LEH.02:002

Lehigh U. Dept. of Mathematics, Bethlehem, Pa.

CHARACTERIZATIONS OF RIEMANN n -SPHERES, by

LEH.02:003, 004; LEH.01:003, 004

G. F. Foeman and C.-C. Hsiung. Nov. 1958, 35p. incl. refs. (Technical rept. no. 2) (AFOSR-TN-58-1045) (AF 49(638)215) AD 222509 Unclassified

Also published in Amer. Jour. Math., v. 81: 691-708, July 1959.

Let M_α be the α th mean curvature of a closed orientable hypersurface V^n ($n \geq 2$) of class C^3 imbedded in the Riemannian manifold V^{n+1} such that "there is a normal coordinate system of Riemann at a fixed point 0 covering the whole manifold V^{n+1} ." Then some characterizations of Riemann n -spheres of the following type are given: Suppose that there exists an odd integer s ($1 < s \leq n$) such that at all points of the hypersurface V^n the function p (= scalar product of the unit normal vector of V^n at a point P and the position vector of P with respect to 0) is of the same sign, $M_1 > 0$ for $i = 1, 2, \dots, s-1$ and either M_{s-1} or M_s is constant; then V^n is a Riemann n -sphere. The case where V^{n+1} is of constant curvature is first considered. (Math. Rev. abstract)

LEH.02:003

Lehigh U. Dept. of Mathematics, Bethlehem, Pa.

UNIQUENESS THEOREMS FOR ALEKSANDROV'S PROBLEM FOR CONVEX SURFACES WITH BOUNDARY, by C.-C. Hsiung. Nov. 1958, 13p. incl. refs. (Technical rept. no. 2, Pt. B) (AFOSR-TN-58-1088) (AF 49(638)215) AD 222510 Unclassified

A new proof of the following uniqueness theorem for Aleksandrov's problem for two convex caps S and S^* is given. The theorem is: Let S and S^* be two orientable convex caps of class C^2 with boundaries C and C^* , respectively, and positive Gaussian curvatures imbedded in a three-dimensional Euclidean space E^3 . Suppose that there is a differentiable homeomorphism H of the cap S onto the cap S^* satisfying the conditions of Aleksandrov's problem. If the homeomorphism H restricted to the boundary C is a translation carrying the boundary C onto the boundary C^* , then the homeomorphism H is a translation carrying the whole cap S onto the whole cap S^* . The establishment of a uniqueness theorem for Aleksandrov's problem for two convex surfaces S and S^* with boundary is also given.

LEH.02:004

Lehigh U. [Dept. of Mathematics] Bethlehem, Pa.

A UNIQUENESS THEOREM ON TWO-DIMENSIONAL RIEMANNIAN MANIFOLDS WITH BOUNDARY, by

C.-C. Hsiung. [1958] [6]p. [AF 49(638)215]

Unclassified

Published in Mich. Math. Jour., v. 5: 25-30, 1958.

The purpose of this paper is to establish the following: Let M_2 and M_2^* be two oriented two-dimensional Riemannian manifolds of class C^2 imbedded in a Euclidean space E_{N+2} of dimension $N+2$ ($N > 0$), with boundaries C and C^* , respectively, and with positive Gaussian curvatures in every normal direction. Suppose that there exists an orientation-preserving differentiable homeomorphism H of the manifold M_2 onto the manifold M_2^* such that at corresponding points the manifolds M_2 and M_2^* have parallel tangent planes and equal sums of the principal radii of curvature associated with every common normal direction. If the homeomorphism H restricted to the boundary C is a translation (strictly speaking: is induced by a translation in the space E_{N+2}) carrying the boundary C onto the boundary C^* , then the homeomorphism H is a translation carrying the whole manifold M_2 onto the whole manifold M_2^* .

LEH.01:003

Lehigh U. Dept. of Physics, Bethlehem, Pa.

CONFORMALLY INVARIANT WAVE EQUATIONS FOR NONLINEAR AND INTERACTING FIELDS, by J. A. McLennan, Jr. Nov. 16, 1956, 12p. (AFOSR-TN-57-26) (AF 18(600)1462) AD 115061 Unclassified

Also published in Nuovo Cimento, Series X, v. 5: 640-647, Mar. 1, 1957.

Derivation of non-linear conformally invariant wave equations for spinors of arbitrary rank are obtained. These include an equation recently proposed by Gürsey. In addition, conformally invariant equations for interacting fields are given.

LEH.01:004

Lehigh U. [Dept. of Physics] Bethlehem, Pa.

THEORY OF FIELDS OF INTEGRAL SPIN GREATER THAN ONE (Abstract), by P. Havas. [1957] [1]p. [AF 18(600)1462] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 189-190, Apr. 25, 1957.

Equations describing wave fields for any integral spin have been established by Fierz. Although the general

LEH.01:005; LEY.02:001-004

form of the equation of motion of singularities of such fields was deduced by Harish-Chandra, this does not assure the existence of a self-consistent theory of arbitrary point singularities. A general theory of multi-pole singularities of spin zero fields was given recently, and the equations of motion of poles and dipoles of spin one fields are well known. For spins greater than one it has been found, however, that it is not possible to have simple poles whose fields satisfy all of Fierz' conditions. It appears that while higher poles are compatible with the field equations, no consistent equations of motion are possible for them. Due to this absence of interaction such fields are unobservable. Thus, at least within the framework of classical linear field theories, interaction of particles appears to be possible only through (neutral or charged) fields of spin zero or one.

LEH.01:005

Lehigh U. [Dept. of Physics] Bethlehem, Pa.

IMPROPER LORENTZ TRANSFORMATIONS, by J. A. McLennan, Jr. [1957] [4p. incl. refs. (AFOSR-TN-58-32) (AF 18(600)1462) AD 148071 Unclassified

Also published in Phys. Rev., v. 109: 986-989, Feb. 1, 1958.

The irreducible representations of the extended Lorentz group, including the space- and time-like reflections, are discussed. It is shown that there exist certain representations which are unique, except for possible changes in sign; that can be used to describe a particle with two states of opposite parity. (Contractor's abstract, modified)

LEY.02:001

Leyden U. Lorentz Inst. (Netherlands).

DENSITY EXPANSIONS OF DISTRIBUTION FUNCTIONS. I. VIRIAL EXPANSION FOR FINITE CLOSED SYSTEMS; CANONICAL ENSEMBLE, by I. Oppenheim and P. Mazur. Nov. 23, 1956 [19p. (AFOSR-TN-57-147) [AF 61(514)961] AD 126436 Unclassified

Also published in Physica, v. 23: 197-215, Mar. 1957.

A method is presented which enables one to obtain density expansions for the distribution functions for finite systems from integro-differential equations involving derivatives of these distribution functions with respect to density. It is shown that the λ^{th} coefficient in the density expansion is a polynomial in $1/N$ of degree λ . Explicit algebraic recursion relations are obtained for these coefficients. The results obtained are derived under the assumption of periodic boundary conditions and a study of this concept is given. (Contractor's abstract)

LEY.02:002

Leyden U. Lorentz Inst. (Netherlands).

DENSITY EXPANSIONS OF DISTRIBUTION FUNCTIONS. II. DENSITY EXPANSIONS IN THE GRAND CANONICAL ENSEMBLE, by P. Mazur and I. Oppenheim. Nov. 23, 1956 [9p. (AFOSR-TN-57-148) [AF 61(514)961] AD 126437 Unclassified

Also published in Physica, v. 23: 216-224, Mar. 1957.

The techniques of the grand canonical ensemble are used to obtain density expansions for distribution functions from integro-differential equations involving derivatives of these functions with respect to density. The results apply to classical and quantum systems. A product condition for the distribution functions is obtained. (Contractor's abstract)

LEY.02:003

Leyden U. Lorentz Inst. (Netherlands).

DENSITY EXPANSIONS OF DISTRIBUTION FUNCTIONS. III. ON THE MOLECULAR THEORY OF DIELECTRIC POLARIZATION, by M. Mandel and P. Mazur. Jan. 1958, 19p. incl. refs. (AFOSR-TN-53-230) (AF 61(514)961) AD 154133 Unclassified

Also published in Physica, v. 24: 116-128, 1958.

A general statistical mechanical formalism is presented which yields a closed expression for the dielectric constant of a system of polarizable dipoles in terms of averages over molecular quantities. The validity of this general formula is not restricted to a spherical sample. Some general aspects of the theory of dielectric polarization are discussed on the basis of the present formalism. An explicit expression is also derived for the total electrostatic energy of the system. (Contractor's abstract)

LEY.02:004

Leyden U. [Lorentz Inst.] (Netherlands).

DENSITY EXPANSIONS OF DISTRIBUTION FUNCTIONS. IV. SOME PROPERTIES OF THE WIGNER DISTRIBUTION FUNCTION IN QUANTUM STATISTICS, by S. R. de Groot. Jan. 1958, 10p. incl. refs. (AFOSR-TN-58-231) (AF 61(514)961) AD 154231 Unclassified

The "Liouville equation" for the Wigner distribution function and the equation for the time derivative of the average of an arbitrary dynamical variable for a system described by an arbitrary Hamiltonian are derived. It is shown the results of Irving and Zwanzig (Jour. Chem. Phys., v. 19: 1171, 1951) for special Hamiltonians and dynamical variables can be obtained from the general scheme. (Contractor's abstract)

LEY.02:005-007; LIE.03:001, 002

LEY.02:005

Leyden U. [Lorentz Inst.] (Netherlands).

DENSITY EXPANSIONS OF DISTRIBUTION FUNCTIONS. V. STATISTICAL MECHANICS OF MATTER IN AN ELECTROMAGNETIC FIELD. MOMENTUM BALANCE OF SYSTEMS WITH MAGNETIZATION AND POLARIZATION. (PRELIMINARY CONSIDERATIONS), by S. R. de Groot. Jan. 1958, 18p. (AFOSR-TN-58-232) (AF 61-514)961) AD 154135 Unclassified

A classical statistical mechanical derivation is given of the macroscopic momentum balance equation for an uncharged fluid with magnetization and polarization in an external electromagnetic field. The theory is based on the classical equations of motion for the constituent particles obtained from the so-called second order Darwin Lagrangian. The pressure and the ponderomotive force in the fluid are defined in terms of averages over microscopic quantities. (Contractor's abstract)

LEY.02:006

Leyden U. [Lorentz Inst.] (Netherlands).

DENSITY EXPANSIONS OF DISTRIBUTION FUNCTIONS. VI. ON THE THERMODYNAMICAL THEORY OF RELAXATION PHENOMENA: ACOUSTICAL RELAXATION, by S. R. de Groot. Jan. 1958, 13p. (AFOSR-TN-58-233) (AF 61(514)961) AD 154136 Unclassified

The thermodynamic theory of acoustical relaxation is reviewed. The theory is set up for a fluid in which heat conduction, viscosity and a relaxation phenomenon may occur. Two approximations are considered. In the first all irreversibility, except the relaxation, is neglected; in the second the other irreversible phenomena are taken into account in first order. In both cases expressions are derived for the velocity of sound. The well-known fact is established that for low frequencies, the relaxation gives rise to a contribution to the bulk viscosity. (Contractor's abstract)

LEY.02:007

Leyden U. [Lorentz Inst.] (Netherlands).

DENSITY EXPANSIONS OF DISTRIBUTION FUNCTIONS. [Final] technical rept. Jan. 1958, 3p. (AFOSR-TN-58-42) (AF 61(514)961) AD 154137 Unclassified

The research performed under this contract in the field of statistical mechanics is summarized. Abstracts are presented describing the various aspects of the work. The studies have included: the development of new methods of obtaining density expansions for the partial distribution functions of fluid systems, with the help of integro-differential equations; the develop-

ment of a general statistical mechanical formalism on the theory of dielectric polarization; an investigation of some properties of the Wigner distribution function; an extension of the statistical mechanical theory of the ponderomotive force in polarizable systems to include systems with magnetic interactions; a survey of existing theories of relaxation phenomena; and clarification of the Curie principle on the influence of symmetry properties of matter on the coupling of irreversible process.

Libre U., Brussels (Belgium). see Free U. of Brussels (Belgium).

LIE.03:001

Liège U. Inst. of Astrophysics, Cointe-Sclessin (Belgium).

SOME RECENT APPLICATIONS OF NUCLEAR QUADRUPOLE RESONANCE IN STRUCTURAL AND RADIATION CHEMISTRY, by J. Duchesne. [1958] 13p. incl. tables, refs. (AFOSR-TN-58-350) (AF 61-514)1212) AD 154255 Unclassified

Also published in Chem. Soc. Symposia, Bristol (Gt. Brit.), 1958 (Special publication no. 12) London, The Chem. Soc., 1958, p. 235-244.

Applications of nuclear quadrupole resonance are restricted to a limited class of isotopes, since nuclei with 0 or half unit spins have no quadrupole moment. The detection of direct quadrupole spectra and the nature of chemical bonds are discussed. Quadrupole coupling constants upon condensation are found to vary from 2 to 12%. The changes observed vary according to the number of H₂ atoms in the molecule and follow the changes of the electric dipole moments. Fine structure and high energy radiation effects are also investigated.

LIE.03:002

Liège U. Inst. of Astrophysics, Cointe-Sclessin (Belgium).

NOTES ON NUCLEAR QUADRUPOLE RESONANCE IN SOLIDS, by J. Duchesne. [1958] 31p. incl. diag. table, refs. (Technical scientific note no. 1) (AFOSR-TN-58-815) (AF 61(514)1212) AD 202638 Unclassified

The study of the damage produced in solids by high energy radiation is based on a systematic analysis of the changes in the intensity of nuclear quadrupole resonance resulting from imperfections induced in a crystal lattice. The following results were obtained by using γ -rays: (1) among the halogenated organic compounds, the aromatics are more radiation resistant than the ionic and alicyclic compounds; (2) the accumulation of chlorines on an aromatic ring does not seriously affect radiation damage; (3) among the halogenated derivatives

LIE.04:001 - LIE.04:004

of benzene, p-dibromobenzene has a weak radiation resistance; (4) the presence of an OH radical in iodo-phenols seems to be responsible for the radiosensitivity of these compounds; (5) sulphur acts as a good protector in iodoform; (6) the molecular radiation resistance is approximately independent of the nature of the substituted halogen in the case of molecules composed of at least 2 benzene rings; (7) the degree of delocalization of the π -electrons seems to govern the radiation resistance among the aromatics; and (8) none of the post-effects characteristic as a sequel in vacuum occur from irradiation of $\text{CHI}_3 \cdot \text{S}_8$ in an oxygen atmosphere.

A special study was undertaken concerning the actions of fast neutrons in NaClO_3 and evidence was obtained that their efficiency in producing damage is about 10 times greater than that of γ -rays from Co^{60} . The problem of the slope of the resonance lines is discussed and suggestions are made in the distribution of the field gradients and in the part played by the induced impurities in the protective effects. (Contractor's abstract)

LIE.04:001

Liège U. Inst. of Experimental Therapeutics, Brussels (Belgium).

STUDIES ON THE MINERAL FRACTION OF BONE AND TEETH, by M. J. Dallemagne, C. Fabry and others. Technical rept. June 1, 1956-May 31, 1957, 1v. incl. diagrs. tables. (AFOSR-TN-57-405) (AF 61(514)-940) AD 132483 Unclassified

Experiments were conducted (1) to establish whether the surface calcium reaction observed during immersion of bone salts in $^{45}\text{CaCl}_2$ solutions are followed by an exchange of the calcium atoms of the phosphate lattice; (2) to determine the nature of the so-called recrystallization process of bone salts; (3) to compare the calcium exchange reaction with the phosphorus exchange reaction; (4) to study the calcium exchange reaction of dentin; and (5) to compare the infrared absorption spectra of bone salts and of synthetic calcium phosphates of various calcium contents (pseudopatites) to obtain information concerning the position of the CO_3 groups and the nature of the water contents of bone salts.

LIE.04:002

Liège U. Inst. of Experimental Therapeutics, Brussels (Belgium).

[EXCHANGEABLE CALCIUM OF THE MINERAL SUBSTANCE OF THE BONE STUDIED WITH THE AID OF ^{45}Ca . III. RECRYSTALLIZATION OF BONE SALTS.]

Le calcium échangeable de la substance minérale de l'os étudié à l'aide du ^{45}Ca . III. Recrystallisation des sels osseux, by M. J. Dallemagne, P. Bodson, and J. Ueten. [1958] [13]p. incl. diagrs. tables, refs. (AF 61-514)940) Unclassified

Published in Bull. Soc. Chim. Biol., v. 40: 232-245, Mar. 21, 1958.

Experiments were conducted which reveal the following:

- (1) Ca^{45} ions exchange with Ca^{40} ions on the surface of the microcrystals. There are two possible interpretations: (a) these calcium ions are located on the real surface of the microcrystals of a hydrated calcium phosphate with a Ca/P ratio of 2.26 and with the same lattice as hydroxyapatite; (b) these calcium ions are chemisorbed at the surface of microcrystals of a defect phosphate;
- (2) the surface exchanged Ca^{45} ions probably migrate into the lattice by diffusion and are entrapped between the crystalline particles which agglomerate; (3) these two phenomena are temperature dependent; (4) their occurrence does not require the presence of a water phase. However, the migration of the surface ions into the crystals occurs when 3 parts/100 of adsorbed water are still present in the solid phase; (5) these two phenomena correspond to the aging process of bone salts, their starting point is the mineralization of bone; and (6) apparently only a fraction of bone salts CO_2 is located at the surface of the microcrystals. (Contractor's abstract)

LIE.04:003

Liège U. Inst. of Experimental Therapeutics, Brussels (Belgium).

[METHOD OF DETERMINATION OF THE ISOTOPIC EXCHANGE OF CARBONATE IONS OF A SOLID] Méthode de détermination de l'échange isotopique des ions carbonate d'un solide, by C. François. [1958] [6]p. incl. diagr. (AF 61(514)940) Unclassified

Published in Bull. Soc. Chim. Biol., v. 40: 519-525, May 9, 1958.

The method for calculating the percentage of isoionic exchange between a solid and a solution containing a radioactive ion was recalled. A description was then given of a technique applicable to the carbonate ions of a solid. (Contractor's abstract)

LIE.04:004

Liège U. Inst. of Experimental Therapeutics, Brussels (Belgium).

[REGARDING THE ISOIONIC EXCHANGE OF THE PHOSPHORUS OF BONE SALTS] A propos de l'échange

LIE.05:001; LIE.06:001;
LAD.01:001, 002

isoionique du phosphore des sels osseux, by P. Bodson.
[1958] [16]p. incl. diagrs. tables, refs. (AF 61(514)940)
Unclassified

Published in Bull. Soc. Chim. Biol., v. 40: 683-698,
June 9, 1958.

As the Ca/P ratio of bone salts is high, the phenomenon of exchange with radioactive phosphorus is accompanied by fixation of $PO_4^{=}$ ions. First the values of

this fixation, its influence on calculated rates of exchange were examined and the exchange itself was studied. On the mineralized bone, figures obtained for percentage of phosphorus exchange were close to those mentioned for calcium in the literature. Fractionated dissolution shows that heating modifies identically accessibility of $PO_4^{=}$ or Ca^{++} ions previously exchanged.

Lastly, exchanges carried out on total bone give higher figures than for mineralized bone, but again for a single sample of total bone, results obtained for $PO_4^{=}$ ions are

similar to those obtained for Ca^{++} . For each of the two ions, exchange rate is lower at the beginning of the experiment, this being apparently due to diffusion restricted by the presence of organic matter. These results therefore show that amounts of Ca^{++} and $PO_4^{=}$

situated on the surface of microcrystals or microcrystalline aggregates, represent the same percentage of the total amount of each of these ions. Heating ($300^{\circ}C$), while modifying the general structure of the mineral bone substance, does not bring about the appearance of a molecule of different structure. (Contractor's abstract)

LIE.05:001

Liège U. Inst. of Experimental Therapeutics, Brussels
(Belgium).

[EXCHANGEABLE CALCIUM OF THE MINERAL SUBSTANCE OF THE BONE STUDIED WITH THE AID OF Ca^{45} . IV. CRITICAL STUDY OF EXPERIMENTAL CONDITIONS] Le calcium échangeable de la substance minérale de l'os étudié à l'aide du Ca^{45} . IV. Étude critique des conditions expérimentales, by L. Richelle and M. J. Dallemagne. [1958] [19]p. incl. diagrs. tables, refs. (AF 61(514)1175) Unclassified

Published in Bull. Soc. Chim. Biol., v. 40: 1133-1151,
Sept. 10, 1958.

It has been demonstrated that pertinent exchange percentage values are only obtained in some well defined experimental conditions, when bone salts are concerned. When those conditions are fulfilled, no information as to the real molecular structure of bone salts can be obtained. (Contractor's abstract)

LIE.06:001

Liège U. Inst. of Experimental Therapeutics, Brussels
(Belgium).

EVIDENCE OF RECRUITING RESPONSES IN THE CAT'S MESENCEPHALIC RETICULAR FORMATION, by J. Schlag. [1958] [2]p. (AF 61(052)22) Unclassified

Published in Experientia, v. 14: 297-298, 1958.

Since it is apparent that an ascending influence exists between the rostral and caudal parts of the so-called centrencephalic structures, it seemed interesting to test the reverse possibility, namely a feedback action of the thalamus upon the brain stem reticular formation. This was done by looking for recruiting responses in the mesencephalic region. The results of the experiments conducted demonstrate the back action of the diffusely projecting system of the thalamus on mesencephalic regions which are physiologically considered as belonging to the reticular system.

LAD.01:001

Little, Arthur D., Inc., Cambridge, Mass.

THE IGNITION OF GASES BY ELECTRICALLY HEATED WIRES, PART I, by L. E. Ashman and W. E. Gordon. Jan. 19, 1958, 19p. incl. illus. diagrs. (AFOSR-TN-58-1010) (AF 18(603)109) AD 206153

Unclassified

If a 1-1/2-cm length of 2-mil tungsten wire is heated in a period of about 100 μ sec, such as by the discharge of a condenser, at the end of the heating period, the temperature distribution along the wire is essentially flat. This fact is used in an investigation of the ignition of gases by electrically heated wires. Since the temperature distribution is flat, the current to maintain the center of the wire at a constant temperature is a measure of the heat flux from the wire to the gas. A theoretical analysis of the heat flow shows that the temperature of the center of the wire is independent of end losses for about 100 μ sec. A general formulation of the problem is applicable to wires of any length and diameter. (Contractor's abstract)

LAD.01:002

Little, Arthur D., Inc., Cambridge, Mass.

THE IGNITION OF GASES BY ELECTRICALLY HEATED WIRES, PART II, by W. E. Gordon, L. E. Ashman, and A. Buchler. Apr. 1, 1958, 16p. illus. diagrs. refs. (AFOSR-TN-58-1011) (AF 18(603)109) AD 206154

Unclassified

Experiments were conducted on the ignition of gases with constant temperature wire ignition sources. The ignition

LIT.01:002, 003; LIT.02:001

of stoichiometric methane-air and stoichiometric hydrogen-air mixtures is characterized by an ignition delay where no visible flame appears. The nature of the ignition delay differs between the two mixtures. In the case of the methane-air system an exothermic reaction occurs during the preignition period. This preignition reaction propagates at a velocity and for a period of time that depend upon the temperature of the wire. Near the end of this period, the reaction accelerates to a more rapidly propagating flame front. In the hydrogen-air mixture no measurable reaction occurs during the preignition period. These observations suggest that the methane-air reaction is at least partially thermal in character while the hydrogen-air reaction is essentially due to a chain carrier mechanism. Some effects of wire size, wire composition, and gas pressure on the ignition delay have been investigated for the case of the hydrogen-air mixture. For a given wire temperature, the ignition delay increases when either the diameter of the wire or the gas pressure are reduced. The magnitude of this reduction in ignition delay agrees, at least to a first approximation, with theoretical considerations of the effect of wire size and gas pressure on ignition delay. (Contractor's abstract)

fore, the expenditure of effort in this area cannot be recommended. (Contractor's abstract)

LIT.01:003

Litton Industries. Research Labs., Beverly Hills, Calif.

THE INHABITED HIGH VACUUM LABORATORY.

Final rept. Jan. 8, 1958, 1v. incl. illus. diagrs. tables.
(AFOSR-TR-58-14) (AF 18(600)1498) AD 148105

Unclassified

A prototype laboratory chamber is described which provides the means of human occupancy, observations, and manual operations in an environment maintained at an absolute pressure of the order of one billionth of an atmosphere. The chamber is 8 ft in diameter and 15 ft long. The occupant is provided with a unique pressure suit which is supplied with oxygen for breathing and ventilation and allows for manual manipulations requiring considerable dexterity. The instrumentation, controls, and auxiliaries which supplement this laboratory chamber make the laboratory a complete facility for experimentation and study under conditions which closely simulate outer space. Several problems were associated with solutions adequate to the existing boundary conditions. These included the design, fabrication, and test (1) of constant volume enclosures for the human arm, wrist, and hand which allow free and low effort manipulation at an internal pressure of 5 psi (above outside ambient); (2) of a recirculating breathing and ventilating system designed to maintain human comfort in absolute vacuum; and (3) of a unique lead detection device used by the occupant to pinpoint leaks from the inside of the laboratory chamber. The preliminary design was completed of an airlock to permit entrance and egress of the inhabitant and equipment without materially disturbing the vacuum in the inner chamber.

LIT.01:002

Litton Industries. Research Labs., Beverly Hills, Calif.

[HIGH VACUUM TEST FACILITIES] by S. Hansen and R. A. Roche. Monthly progress rept. July 18, 1957 [16]p. incl. illus. refs. (AFOSR-TN-58-239) (AF 18-(600)1498) AD 154141

Unclassified

Continued trouble has been experienced with the mechanical pumps since substitution of Tri-Cresyl-Phosphate for pump oil. It appears that passing dry air through the pumps may result in sufficient improvement in pumping characteristics to allow for continuing the use of T.C.P. The medical instrumentation is now working satisfactorily; however, considerable difficulty was experienced in eliminating noise from the medical signal leads. Eight trial inhabited runs were undertaken during this month. Two runs were aborted due to difficulty with medical instrumentation and one was aborted due to a decrease in partial oxygen pressure as a result of an air leak in the CO₂ analyzer. The other runs were

considered successful. On one run an equivalent altitude of 85 miles was reached during the test. A series of tests were run to evaluate the transient conditions resulting from operation of the emergency air system. Results indicate that the noise levels and temperatures experienced following operation of the emergency system are higher than desirable but are acceptable on an interim basis until system modifications can be made. The research study of past work relating to the proposed thermal equilibrium experiment has been completed. It has been determined that much of the data regarding specific characteristics of materials (reflectivity, emissivity vs. wavelength) is already available. There

LIT.02:001

Litton Industries. Space Research Labs., Beverly Hills, Calif.

LITTON RESEARCH ON PLASMA ACCELERATION

(Abstract), by G. Fonda-Bonardi. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274) (AF 49(638)-345)

Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The magnetohydrodynamics of accelerating gas plasmas is being studied. The magnetic field employed may be considered to be a radial field which is swept linearly with constant acceleration. That portion of the field which is of interest is produced within a long evacuated glass tube coincident with the axis of travel of the magnetic field. A small quantity of pre-ionized gas is admitted at the end of the tube coincident with the start of

LOC. 01:003-005; LON. 01:001

the field's acceleration down the tube. The action of the moving field is to fully ionize the gas and pinch it into a conducting toroid. The reaction between the toroid current and the radial field results in the toroid of plasma being accelerated down the tube at a velocity slightly less than that of the magnetic field. The method of achieving the desired field makes use of a series of single turn coils wound concentric with the evacuated tube and appropriately spaced along its length. These are excited in sequence to develop the moving field. Electric energy is provided by individual high voltage capacitors of appropriate energy which are discharged through the coils in sequence.

LOC.01:003

Lockheed Aircraft Corp. Missile Systems Div., Palo Alto, Calif.

FREE OSCILLATIONS OF A GAS IN AN ELASTIC CYLINDRICAL SHELL, by H. V. Hahne. Aug. 30, 1957, 28p. incl. diagrs. (Technical note no. 2; rept. no. LMSD-2160) (AFOSR-TN-57-348) (AF 18(603)146) AD 132421 Unclassified

Acoustic oscillations of a compressible gas contained in an elastic cylindrical shell are investigated. The mass and the elastic properties of the shell, as well as the coupling between the gas and the shell, are taken into consideration. First, the general case which includes all possible modes is considered, and the frequency equation is derived. Then the two special cases of purely tangential and of purely longitudinal modes are considered. For the tangential modes numerical results for an assumed configuration are obtained and compared to those for an elastic shell in vacuum and for a rigid shell of analogous dimensions. It is found that, for the tangential modes, certain natural frequencies of the elastic gas-filled shell resemble closely the natural frequencies of a gas in a rigid shell, while the remaining natural frequencies are quite similar to the frequencies of an elastic shell in vacuum.

LOC.01:004

Lockheed Aircraft Corp. Missile Systems Div., Palo Alto, Calif.

A SANDWICH BURNER MODEL FOR THE COMPOSITE SOLID PROPELLANT, by W. Nachbar and J. M. Parker. Sept. 25, 1957, 39p. incl. diagrs. (Rept. no. LMSD-2181) (AFOSR-TN-57-418) (AF 18(603)146) AD 132497 Unclassified

An idealized solid propellant sandwich burner, composed of alternating flat slabs of fuel and oxidizer which are ignited edgewise, is proposed for theoretical study of the functional relationship of the regression rate, pressure, and surface temperature in the combustion of composite solid propellants, and the dependence of this

relationship on geometry and on physical and chemical material properties. The work of H. N. Powell on the gaseous sandwich burner is reviewed in detail to clarify the assumptions and certain mathematical procedures used there. An eigenvalue problem for the solid propellant sandwich is formulated in two ways: one, by an extension of Powell's analysis, and, two, by an application of the Shvab-Zeldovitch approach. (Contractor's abstract)

LOC.01:005

Lockheed Aircraft Corp. [Missile Systems Div.] Palo Alto, Calif.

OSCILLATIONS OF A GAS IN AN ELASTIC CYLINDRICAL SHELL, by H. V. Hahne. [1958] [8p. incl. diagrs. (AF 18(603)146) Unclassified

Published in Proc. Third U. S. Nat'l. Congress of Appl. Mech., Brown U., Providence, R. I. (June 11-14, 1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 753-760.

An analysis is made of the natural frequencies and modes of oscillation of a compressible gas contained in an elastic cylindrical shell. The mass and the elastic properties of the shell, as well as the coupling between the gas and the shell are taken into consideration. First, the general case which includes all possible modes and their combinations is considered, and the corresponding frequency equation is derived. This general frequency equation is then reduced to two special cases, that of purely circumferential and that of purely longitudinal modes. Numerical solutions of the frequency equation are obtained for the circumferential modes of a gas-filled steel shell of given dimensions. (Contractor's abstract)

LON.01:001

London U. Imperial Coll. of Science and Tech. (Gt. Brit.).

THE ANALOGUE SOLUTION OF TEMPERATURE DISTRIBUTION AND EXTINCTION IN AN IDEALIZED CYLINDRICAL FLAME, by D. B. Spalding and M. D. Samain. Jan. 1958 [17]p. incl. diagrs. (AFOSR-TN-58-216) (AF 61(514)1014) AD 154117 Unclassified

To assist the theoretical study of combustion problems a resistance network analogue has been built. The analogue solves one dimensional nonlinear heat conduction and generation problems with two point boundary conditions. The particular problem studied is the extinction of a pepper pot combustion chamber as influenced by turbulence level. The analogue consists of a line of resistances. The voltages at the network points are analogous to temperature. Currents injected into the network points are analogous to heat released at those points. The network points are scanned automatically by a rotating switch and a function generator is used to

LON. 01:002; LON. 02:001;
LSU. 01:002, 003

adjust the currents at each point. The analogue produces a solution in a few seconds and the resulting temperature distribution and reaction distribution is displayed on a cathode ray tube along with the function generator input/output curve. (Contractor's abstract)

LON.01:002

London U. Imperial Coll. of Science and Tech. (Gt. Brit.).

APPROXIMATE SOLUTIONS OF TRANSIENT AND TWO-DIMENSIONAL FLAME PHENOMENA: CONSTANT-ENTHALPY FLAMES, by D. B. Spalding. [1958] [21]p. incl. diagrs. tables. (AFOSR-TN-58-807) (AF 61(514)1014) AD 202362 Unclassified

Also published in Proc. Royal Soc. (London), v. 245A: 352-372, 1958.

The 'profile' methods of boundary-layer theory are adapted to predict the behavior of the transient flames resulting from contact of semi-infinite burnt and unburnt gas masses, contact of unburnt gas with an adiabatic catalyst, immersion of a finite slab of unburnt gas in a large mass of hot gas, and immersion of a finite slab of burnt gas in a large mass of unburnt. Comparison with some exact solutions suggests that the accuracy is normally better than 20%. The method is simple to use. The results are also relevant to two-dimensional steady-state flames.

LON.02:001

London U. Imperial Coll. of Science and Tech. (Gt. Brit.).

RESEARCH ON THE CREEP OF METALS, by E. N. da C. Andrade. Annual rept. no. 1, Feb. 15, 1957-Jan. 15, 1958 [24]p. incl. illus. diagrs. (AFOSR-TN-58-227) (AF 61(514)1177) AD 154129 Unclassified

A study was made of the mechanism of creep in metals and the manner in which the process is governed by the behavior of the crystal grains. The method of simple shear, which uses an apparatus described by Andrade and Jolliffe (Proc. Royal Soc., v. 213: 3, 1952), was used. The specimen was in the form of a flat disk about 16 cm in diam and 1.1 cm thick with a circular groove cut into one face leaving an annulus of metal about 1 mm thick and 12 mm wide which was the section subjected to shear stress by either clockwise or counterclockwise torquing. The temperature of the specimen was carefully controlled, strain was automatically recorded, and the surface of the test section was microphotographed during creep. Observations included the effect of stress and temperature on the linear rate of creep, the effects of periods of off-load, and the effects of reversal of stress on a lead containing 0.0045% Ag and 0.0038% Cu. Other experiments were performed on a commercial lead during which the behavior of the crystal grains was observed for short periods of strain (6 hr, 15%)

followed by reversal of creep (5 hr) and for increased temperatures, stress, and time. A full interpretation of the results is dependent on further observations and study, but a preliminary discussion is presented.

Lorentz Inst., Leyden (Netherlands). see Leyden U.
Lorentz Inst. (Netherlands).

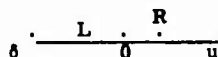
LSU.01:002

Louisiana State U., Baton Rouge.

CLANS WITH ZERO ON AN INTERVAL, by H. Cohen and L. I. Wade. Jan. 14, 1957, 21p. (AFOSR-TN-57-34) (AF 18(603)89) AD 115072 Unclassified

Also published in Trans. Amer. Math. Soc., v. 88: 523-535, July 1958.

The object of the paper is to characterize clans with zero on an interval. Partial results in this connection have been found by Faucett and Clifford. In addition the case when 0 (the zero) is an end point has been studied by Mostert and Shields. Finally, a forthcoming paper by Clifford on linear mobs with idempotent end points will contain many pertinent results. S is always a clan on an interval with zero. It is well known (e.g., Wallace) that the unit u is an end point. It can be assumed that it is the right hand end point (the other case, of course, can be handled by a dual argument). Call the other end point δ . Let L be the interval $[\delta, 0]$ and R the interval $[0, u]$ so that the following diagram for S is:



One may define a partial order $<$ on S as follows: $x < y$ if and only if x separates y and 0, (i.e., $x < y$ if both x and y are on the same side of 0 and x is closer to 0 than y is). The notation $\ell, \ell_1 \in L$ and $r, r_1 \in R$ is used.

LSU.01:003

Louisiana State U., Baton Rouge.

NOTE ON WEAK CUT-POINTS IN CLANS, by R. J. Koch. May 15, 1957 [9]p. incl. refs. (AFOSR-TN-57-241) (AF 18(603)89) AD 126538 Unclassified

Also published in Duke Math. Jour., v. 24: 611-616, Dec. 1957.

A clan is a compact connected semigroup with unit. Since a clan need not be a homogeneous space, one may inquire as to the topological position of algebraically distinguished points, with some hope of a useful answer. Theorem 1 is of a somewhat technical nature, identifying a topologically defined subset as a normal subgroup of

LSU.01:004 - LSU.01:008

H_u , the maximal subgroup of the clan which contains the unit, u . This leads to results germane to the conjecture that the unit of a clan which is not a group cannot be a weak cutpoint. The reviewer has conjectured that finite-dimensional homogeneous clans are necessarily groups. Theorem 4 states that the unit of a homogeneous clan which is not a group (though perhaps infinite-dimensional) cannot be a weak cutpoint, and that there must be small open sets about u with connected complements. Theorem 5 is the result that, in a one-dimensional clan which is not a group, the unit cannot cut any subcontinuum. (Math. Rev. abstract)

LSU.01:004

Louisiana State U. [Baton Rouge].

ARCS IN PARTIALLY ORDERED SPACES, by R. J. Koch. May 22, 1958 [8p. incl. refs. (AFOSR-TN-58-397) (AF 18(603)89) AD 154308 Unclassified

Also published in Pacific Jour. Math., v. 9: 723-728, 1959.

A theorem is presented on the existence of arcs in partially ordered spaces, and several applications are made to topological semigroups. The hypotheses are motivated by the structure of the partially ordered set of principal ideals of a compact connected topological semigroup with unit element. Among the applications are the following: (1) a compact, connected topological semigroup with a unit element contains an arc; and (2) a locally compact, connected topological semigroup with zero element, each of whose elements is idempotent, is arc-wise connected. The word arc is used in the sense of continuum irreducibly connected between two points. All spaces are assumed to be Hausdorff, but not necessarily metric. Simple non-metric examples of the theorems are furnished by the long line, i.e., the ordinals up to and including Ω , filled in with intervals, the operation being $a \cdot b = \min(a, b)$.

LSU.01:005

Louisiana State U. [Baton Rouge].

CONTINUOUS HOMOMORPHIC IMAGES OF REAL CLANS WITH ZERO, by H. Cohen and I. S. Krulic. June 5, 1958, 5p. (AFOSR-TN-58-433) (AF 18(603)89) AD 158237; PB 137437 Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 106-109, Feb. 1959.

A real clan S is a topological semigroup with zero and unit whose underlying space is a closed interval of real numbers. It is shown that a continuous homomorphic image of S is either (1) a real clan or (2) a triad (in

which case its zero is an end point). An example is given to illustrate (2). (Math. Rev. abstract)

LSU.01:006

Louisiana State U. [Baton Rouge].

AFFINE SEMIGROUPS I, by H. Cohen and H. S. Collins. Aug. 20, 1958, 26p. (AFOSR-TN-58-709) (AF 18(603)89) AD 162243; PB 137432 Unclassified

Also published in Trans. Amer. Math. Soc., v. 93: 97-113, Oct. 1959.

Consideration is given to some properties of general affine semigroups. A complete characterization of all one and two dimensional compact affine topological semigroups and of all one dimensional affine semigroups and of all possible multiplications is listed in each of these cases. Proofs are included which show that the minimal ideal of each one or two dimensional compact affine topological semigroup is complex. A similar statement can be made for three dimensional semigroups with unit, and examples are given which show the theorem is false for dimension three without unit and in general for all semigroups of dimensions greater than four.

LSU.01:007

Louisiana State U., Baton Rouge.

DUOMORPHISMS AND CLANS ON AN INTERVAL, by R. C. Phillips. Aug. 20, 1958, 8p. (AFOSR-TN-58-710) (AF 18(603)89) AD 162244 Unclassified

The paper characterizes the clans (compact connected Hausdorff topological semigroups with an identity element) which are homeomorphic to a unit interval and which have a nondegenerate kernel (minimal two-sided ideal). X is a topological space with a C considered to be irreducibly connected between two points x and y in X . If C is connected, x and $y \in C \subset X$ and there is no connected proper subset of C which contains both x and y . If for any two points x and y of X there exists exactly one continuum C such that C is irreducibly connected between x and y , one says X is uniquely arcwise connected. If X is uniquely arcwise connected and if a and b are elements of X , $[a, b]$ denotes the continuum in X which is irreducibly connected between a and b . Definitions and proofs are given for the theorems presented.

LSU.01:008

Louisiana State U., Baton Rouge.

ORDERED SEMIGROUPS IN PARTIALLY ORDERED SEMIGROUPS, by R. J. Koch. Sept. 11, 1958, 6p. (AFOSR-TN-58-739) (AF 18(603)89) AD 201505; PB 136852 Unclassified

LSU.01:009, 010; LOU.01:005, 006

Also published in Pacific Jour. Math., v. 10: 1333-1336, 1960.

A locally compact connected partially ordered local semigroup with unit is shown to contain a compact connected linearly ordered local subsemigroup (containing the unit). This is an extension of a theorem of Gleason (Proc. Nat'l. Acad. Sciences, v. 36: 636-667, 1950). It follows that a compact connected partially ordered semigroup with unit and zero contains a standard thread joining the zero to the unit. (Contractor's abstract)

LSU.01:009

Louisiana State U. [Baton Rouge].

ON THE SEMIGROUP STRUCTURE OF CONTINUA, by R. P. Hunter. Sept. 11, 1958, 21p. incl. refs. (AFOSR-TN-58-740) (AF 18(603)89) AD 201506; PB 136853
Unclassified

Also published in Trans. Amer. Math. Soc., v. 93: 356-368, Nov. 1959.

This paper contains an investigation of the structure of topological semigroups defined on continua. The first part of the paper deals with a semigroup S irreducible between two points with $S^2 = S$. The author shows that if S has a zero, then S is an arc. The latter part is devoted to semigroups on hereditarily unicoherent continua. As a corollary the author obtains the result that a 1-dimensional clan with zero is arcwise connected. The proofs given, however, are somewhat hard to follow due to typographical errors and careless statements by the author. It is sometimes questionable if the author actually means what his statements imply. For example, in Definition 1.3, the author obviously means, though he does not state it, for the sets A , B , and C to be pairwise disjoint; for without this restriction Theorem 1.5 is false. Also the proof of Theorem 1.11 is inadequate; for the claim made that, if V is an open set containing A , the complement of a maximal prime ideal, then $\bar{S}V$ must have finitely many components, is clearly false. (Math. Rev. abstract)

LSU.01:010

Louisiana State U., Baton Rouge.

HOMOMORPHISMS AND TOPOLOGICAL SEMIGROUPS, by N. J. Rothman. Sept. 11, 1958, 13p. incl. refs. (AFOSR-TN-58-741) (AF 18(603)99) AD 201507; PB 136854
Unclassified

Some of the structures of compact commutative Hausdorff topological semigroups are discussed. The characters (continuous complex-valued homomorphisms) of such semigroups are considered, and some results analogous to the character theory of locally compact commutative groups are obtained. (Contractor's abstract)

LOU.01:005

Louvain U. Lab. for Inorganic and Analytical Chemistry, Brussels (Belgium).

INTERPRETATION OF SOME FLAME SPECTRA IN TERMS OF REACTION KINETICS, by G. Nenquin, P. Thomas, and A. Van Tiggelen. [1956] [10]p. incl. tables. (AF 61(514)814)
Unclassified

Published in Bull. Soc. Chim. Belg., v. 65: 1072-1081, Nov.-Dec. 1956.

The spectral intensity emitted by different radicals in some flames sustained by some different combustibles and supporters of combustion (NH_3 , H_2 , C_2H_4 and $\text{C}_2\text{H}_3\text{Cl}$ vinyl chloride) on one hand and N_2O , O_2 , on the other, has been measured. The activation energy of production reactions for radicals can be calculated apart from the measured intensities of various dilution degrees, on the condition of knowing the temperatures in the front of the flame. It is proved that for certain radicals at least, the intensity variation for an increasing dilution by an inert gas is narrowly connected to the variation of the flame propagation velocity. For these radicals, the activation energies are close to those in the chain forming reactions.

LOU.01:006

Louvain U. Lab. for Inorganic and Analytical Chemistry, Brussels (Belgium).

FLAME PROPAGATION IN MIXTURES OF LESS USUAL FUELS WITH OXYGEN, by A. Van Tiggelen, J. Van Wonerghem, and P. J. Sootmaekers. [1957] [18]p. incl. diagrs. table. (AFOSR-TN-57-276) (Bound with its AFOSR-TR-57-27, Feb. 1957; AD 126445) (AF 61(514)814) AD 126578
Unclassified

Also published in Bull. Soc. Chim. Belg., v. 65: 899-917, Sept.-Oct. 1956.

During this study, measurements were made of the flame-propagation velocities, flame temperatures, and distances between Schlieren and luminous flame cones for mixtures of O_2 and H_2S , CS_2 (H_2 -free), and a chlorinated hydrocarbon (vinylchloride), respectively, all being diluted with N_2 . Results obtained by using a mixture of $\text{Et}_2\text{O} + \text{O}_2 + \text{N}_2$ are presented for comparison.

It is concluded that the flames of the mixtures (I) investigated here do not differ much from the usual hydrocarbon flames. Any differences result mainly from variation of the branching activation energy and from variation of the molecular weights of the chain carriers, which in the case of I are 17 or higher.

LOU.01:007; LOU.02:001;
LOU.03:001, 002

LOU.01:007

Louvain U. Lab. for Inorganic and Analytical Chemistry,
Brussels (Belgium).

CONTRIBUTION TO THE KNOWLEDGE OF REACTION KINETICS IN PREMIXED LAMINAR FLAMES, by A. Van Tiggelen, J. Van Wouterghem and others. Feb. 1957, 99p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-27) (AF 61(514)814; continued by AF 61(514)1245) AD 126445 Unclassified

In this volume, the importance of the branching condition in flame propagation is considered. A general, but simple, theory for flame propagation is derived on the basis of the kinetics of chain reactions. This theory provides a good correlation between different flame properties and even between flames propagating in mixtures of different fuels and oxidants. Measurements are reported of flame temperature, burning velocity, and flame-front thickness for mixtures of the following fuels and oxidants: CO, H₂, NH₃, C₂H₂, (C₂H₅)₂O, C₂H₃Cl, H₂S, N₂H₄, CS₂, O₂, N₂O, Cl₂, and F₂. Over-all activation energies, assumed to be approximately equal to the activation energy of the branching process, are derived from the experimental data. In addition, the intensities of the different bands emitted in the spectra are determined for the following flames: NH₃/O₂, C₂H₂/O₂, C₂H₂/N₂O, C₂H₄/O₂, and C₂H₃Cl/O₂. An attempt is made to give a kinetic

interpretation of these intensities, assuming chemiluminescent excitation of the emitting radicals. The results of the above work, accomplished on AFOSR-sponsored tasks at Louvain U. (Belgium), are reported in the following chapters:

Chapter II. FLAME PROPAGATION IN GASEOUS MIXTURES CONTAINING NITROUS OXIDE AS OXIDANT, by A. Van Tiggelen and J. Van Wouterghem. [1957] [17]p. incl. diagrs. tables. [AFOSR-TN-56-448];

Chapter III. THE INFLUENCE OF HYDROGEN ON CARBON MONOXIDE - OXYGEN FLAMES, by A. Van Tiggelen and P. J. Sootmaekers. [1957] [9]p. incl. diagrs. table. [AFOSR-TN-56-84];

Chapter IV. FLAME PROPAGATION IN MIXTURES OF LESS USUAL [COMMON] FUELS WITH OXYGEN, by A. Van Tiggelen, J. Van Wouterghem, and P. J. Sootmaekers. [1957] [18]p. incl. diagrs. table. [AFOSR-TN-57-276]; and

Chapter V. COMPARATIVE STUDY OF C₂H₂/O₂ AND C₂H₂/N₂O FLAME SPECTRA, by J. Van Tiggelen, J. Vaerman, and G. Nenquin. [1957] [16]p. incl. illus. diagrs. tables. [AFOSR-TN-56-83].

LOU.02:001

Louvain U. Lab. for Inorganic and Analytical Chemistry,
Brussels (Belgium).

FLUORINE AND CHLORINE FLAMES, by P. J. Sootmaekers and A. Van Tiggelen. [1958] [12]p. incl. diagrs. tables, refs. (AFOSR-TN-58-119) (Sponsored jointly by [Air Force Office of Scientific Research] under AF 61(514)1245; continuation of AF 61(514)814, and [Fonds National de la Recherche Scientifique (Belgium)] AD 152027 Unclassified

Also published in Bull. Soc. Chim. Belg., v. 67: 135-146, 1958.

Flame propagation velocities have been measured in H₂/Cl₂, H₂/F₂, CH₄/F₂ and CO/F₂ mixtures at different fuel/oxidant ratios and different dilutions. Corresponding flame temperatures have been calculated. Activation energies are deduced for the following mixtures: 10 kcal (H₂/Cl₂ flames); 11 kcal (H₂/F₂ flames); 18 kcal (CO/F₂ flames) and 9.5 kcal (CH₄/F₂ flames). It is assumed that these values are the activation energies of the branching processes involved in the reaction mechanism. (Contractor's abstract)

LOU.03:001

Louvain U. Lab. of Chemical Physics, Brussels (Belgium).

[A GENERAL SURVEY ON LUMINESCENCE OF CRYSTALS] Luminescences cristallines, by A. Luyckx. Mar. 1957, 21p. incl. illus. diagrs. refs. (AF 61(514)-1118) Unclassified

Published in Revue des Questions-Scientifiques, v. 18: 15-45, Jan. 20, 1957.

A general review is presented of mechanisms considered to explain a number of phenomena involved in luminescence of crystals.

LOU.03:002

Louvain U. Lab. of Chemical Physics, Brussels (Belgium).

STUDIES ON THE MECHANISM OF ELECTROLUMINESCENCE, by A. Luyckx and S. Ries. Apr. 1957 [30]p. incl. illus. diagrs. refs. (Technical note no. 1) (AF 61-(514)1118) Unclassified

It is generally believed that in crystals like ZnS, the absorption of photons brings an electron from the valency band to the conducting band, if the speed of photon absorption is greater than the velocity of electron necessary to make the electron jump the forbidden band. In electroluminescence the field accelerates electrons

LOU.03:003 - LOU.03:005

which reach the conducting band. If they do not fall into electron traps, they collide with luminescent centers. In condensers a loss angle (δ) results from displacement polarizability. It is believed that in electroluminescence δ is the consequence of the collisions of electrons and luminescent centers. An important part of the energy of these collisions is transformed into light. The purpose of this research is to study the relation between δ and light emitted. Results show that δ increases with light emitted and reaches values as high as 73. For condensers without EL powder and for condensers constructed with fluorescent or phosphorescent powders with the same dielectric binder, δ does not increase. It is felt that at least with ZnS phosphors, luminescence is related with photocurrent, and that electrons move through the crystal, but that these electrons do not meet EL centers. Condensers prepared with CuO give constant values in spite of the fact that CuO is a semiconductor. To date all of these experiments have shown that δ increases only in EL condensers. Oscillograms, which appear as a second method to study δ , particularly in EL of single crystals, have been taken, and the results obtained appear to be comparable to those obtained by other researchers in the field of single crystal electroluminescence.

LOU.03:003

Louvain U. Lab. of Chemical Physics, Brussels (Belgium).

STUDIES ON THE MECHANISM OF ELECTROLUMINESCENCE, by A. Luyckx, J. Vandewauwer, and S. Ries. Annual technical rept. Nov. 15, 1956-Nov. 15, 1957, 1v. incl. diagrs. tables. (AFOSR-TN-58-153) (AF 61(514)-1118) AD 152179; PB 142162 Unclassified

The present research is the first systematic work about electrical and dielectrical measurements concerning electroluminescent powders. Dielectric loss, resistivity and capacity were studied in function of ac voltage applied at the industrial frequency of 50 Hz; analogous measurements were made with phosphorescent powders and compared to electroluminescent ones.

LOU.03:004

Louvain U. Lab. of Chemical Physics, Brussels (Belgium).

STUDIES ON THE MECHANISM OF ELECTROLUMINESCENCE, by A. Luyckx, J. Vandewauwer, and S. Ries. Nov. 15, 1957-June 15, 1958, 19p. incl. illus. diagrs. (Technical note no. 2) (AFOSR-TN-58-875) (AF 61(514)-1118) AD 203913 Unclassified

Also published in Proc. Internat'l. Conf. on Solid State Physics in Electronics and Telecommunications, Brussels (Belgium) (June 2-7, 1958), N. Y., Academic Press, v. 4 (Part 2): 671-679, 1960.

ZnS single crystals prepared by sublimation were electroluminescent only after activation. The threshold of electroluminescence in ac field equals 500 volts/cm. Electrode zones give more intense glows. The brightness waves excited by half-wave fields show a peak in phase with the field. This peak is mostly due to anodic zone. It is attributed to injected charges. Our experiments were done on nine crystals prepared by the same method. Two types of crystals were identified. The first type shows a reverse current at the end of a half-wave field excitation. There is coincidence between the peak of this current and the out-of-phase light peak. This light is attributed to electrons under the influence of the space-charge field. With the second type of crystals there was no reverse current. The current wave and brightness wave are in phase with the field. With dc applied fields, some crystals show glows in the anodic region. Inversion of polarity provokes migration of the glowing zone towards the new anode. This was attributed to the migration of ions. Brightness waves obtained with half-wave excitation fields are not the same after dc field has been applied. The in-phase peak is less important; the dc field modifies the crystal. (Contractor's abstract)

LOU.03:005

Louvain U. Lab. of Chemical Physics, Brussels (Belgium).

DIELECTRICAL PROPERTIES OF ELECTROLUMINESCENT AND PHOSPHORESCENT ZINC SULPHIDES AND ASSUMPTIONS ON MECHANISM OF ELECTROLUMINESCENCE, by A. Luyckx, J. Vandewauwer, and S. Ries. [1958] [17]p. incl. diagrs. table. (Also bound with its AFOSR-TN-58-153; AD 152179) (AF 61(514)-1118) Unclassified

Published in Ann. Soc. Scientifique Bruxelles, Series I, v. 72: 58-74, June 18, 1953.

Dielectric loss, resistivity and capacity of electroluminescent (EL) condensers were studied in function of ac voltage applied, at the industrial frequency of 50 Hz; analogous measurements were made with phosphorescent powders and compared to EL. For EL condensers the loss angle ($\text{tg } \delta$) increases in function of applied voltage in some experiments from 0.05 to 1.91; no increase of $\text{tg } \delta$ was found for phosphorescent condensers. Resistance, R_p , of equivalent circuit for EL condensers decreases with increasing applied ac voltage; it does not do so for phosphorescent powders. Capacity, C_p , increases slightly for EL; it does not for phosphorescent powders. In dc fields, EL powders are more conductive than phosphorescent ones. The increase of $\text{tg } \delta$ for EL condensers has the same shape as the curve luminescence versus voltage. These results are inconsistent with a previous assumption that an essential difference between EL and phosphorescent powders lies in the presence of electron traps in the phosphorescent powders. Experiments showed that $\text{tg } \delta$ variation is partially due to internal processes in EL microcrystals and partially to the potential barrier cathode-crystals. A physical

LOV.01:001; LOV.02:001, 002

meaning of tg δ increase is proposed: It is due partly to an increase in the number of donor centers and partly to the possibility for electrons to jump potential barriers more easily. (Contractor's abstract)

LOV.01:001

Lovelace Foundation for Medical Education and Research,
Albuquerque, N. M.

AVIATION MEDICINE: SELECTED REVIEWS, ed. by
C. S. White, W. R. Lovelace II, and F. G. Hirsch.
London, Pergamon Press, 1958, 305p. Incl. illus.
diags. tables, refs. (NATO AGARDograph rept. no.
25) (AF 18(600)858) Unclassified

This book contains the following papers: (1) Spirometric methods (discusses direct spirometry and spirometry, and indirect spirometry), by U. C. Luft; (2) High-speed motion picture photography as an aid in bio-medical investigation, by M. A. Palmer; (3) The measurement of atmospheric ozone, by I. G. Bowen; (4) Methods and apparatus for the study of stress reactions and metabolic changes, by B. B. Longwell; (5) Dosimetry of ionizing radiations, by J. L. Howarth; (6) Some technical developments applicable to problems in pathology, by T. L. Chiffelle; (7) Temperature measuring techniques for aviation physiological research, by F. G. Hirsch; (8) The analysis of respiratory gases, by C. S. White; (9) Aerosols: physical properties, instrumentation and techniques, by A. E. Reif; (10) Transducers: pressure-transformer type, by J. Clark; (11) Spectrometric methods, by C. S. White and W. R. Lovelace II; and (12) Gas sampling methods, by N. P. V. Lundgren. A brief summary of each review has been prepared to familiarize the reader more fully with the contents of each author's contribution.

LOV.02:001

Lovelace Foundation for Medical Education and Research,
Depts. of Respiratory Physiology and Engineering,
Albuquerque, N. M.

QUANTITATIVE EMISSION SPECTROSCOPY AS A
MEANS OF ANALYZING RESPIRATORY GASES, by C.
S. White, W. H. Lockyear and others. [1958] [13]p. Incl.
diags. table, refs. (AFOSR-TN-58-480) [AF 18(603)80]
Unclassified

Presented at 25th annual meeting of the Aero. Med.
Assoc., Washington, D. C., Mar. 31, 1954.

Also published in Jour. Aviation Med., v. 26: 104-116,
Apr. 1955.

A Beckman DU spectrophotometer was modified to study
the emission spectra of dry N_2 , O_2 , and CO_2 when the
gases were energized electrically in an evacuated quartz

discharge tube. The spectra were determined from
2000-5000A at a tube pressure of 1000 μ and from 2000-
5800A at pressures of 200 μ . In eight spectral regions
emission phenomena were such that determination of
 CO_2 by the emission method might be possible, e.g.,
near 5840, 5580, 5180, 4820, 2880, 2820, 2658A, and
between 2000 and 2200A. Exploration of the 4820A region
from 4810-4840A indicated that emission at 4815A was
of potential use for CO_2 analysis, but that with the tech-
nique employed the results were only consistent if the
 N_2 - O_2 ratio in the CO_2 containing gas was fairly con-
stant. The resolution available with the method used was
insufficient to allow practical determination of CO_2 in
expired air under circumstances in which the O_2 - N_2
ratio varied widely, such as in O_2 breathing. The utility
of the 4815A spectral region in CO_2 analysis could be
increased if a spectrometric method of greater resolu-
tion were available. It was felt that the use of a grating
spectrograph should be investigated, as should the use
of a metal-free discharge tube energized by high fre-
quency rather than dc voltage. (Contractor's abstract)

LOV.02:002

Lovelace Foundation for Medical Education and Research,
Depts. of Respiratory Physiology and Engineering,
Albuquerque, N. M.

EMISSION SPECTROSCOPY IN ANALYSIS OF RESPIRA-
TORY GASES. II. CARBON DIOXIDE ANALYSIS USING
THE CARBON DIOXIDE DOUBLETS NEAR 2896A, by C.
S. White, L. C. Watkins, Jr., and E. E. Fletcher. [1958]
[13]p. Incl. illus. diags. table, refs. (AFOSR-TN-58-
481) [AF 18(603)80] Unclassified

Presented at 27th annual meeting of the Aero Med.
Assoc., Chicago, Ill., Apr. 17, 1956.

Also published in Jour. Aviation Med., v. 27: 332-334,
Aug. 1956.

A small-volume rf energized light source suitable for
activation of the CO_2 emission doublets located near
2883 and 2895A is described. The discharge tube proved
an adequate emission source for either the Beckman DU
spectrophotometer or the Applied Research Laboratories
quantograph and the instruments were utilized independ-
ently to study the emission characteristics of "dry" re-
spiratory gases, particularly near the 2900A region of
the spectrum. A simple modification of the spectropho-
tometer allowed the instrument to be used as a mono-
chromator, and under appropriate operating conditions,
satisfactory performance as a continuous CO_2 analyzer
was achieved using the emission attributed to CO_2^+ at
2896A. At this wavelength, the relation between emission
intensity and CO_2 concentration proved linear whether

LOV.02:003 - LOV.02:005

the gas was present in air or in O_2 . However, the CO_2 in air curve was parallel to, but consistently above, that for CO_2 in O_2 . The relative youth of the emission method as a technique for continuous quantitative gas analysis is pointed out, some of the pertinent literature is summarized and a general discussion of the data is presented. (Contractor's abstract)

LOV.02:003

Lovelace Foundation for Medical Education and Research.
Depts. of Respiratory Physiology and Engineering,
Albuquerque, N. M.

EMISSION SPECTROSCOPY IN ANALYSIS OF RESPIRATORY GASES. III. NITROGEN ANALYSIS USING THE 2372A SINGLET AND OXYGEN ANALYSIS EMPLOYING THE 7772-75A TRIPLET, by C. S. White, L. C. Watkins, Jr., and E. E. Fletcher. [1958] [10]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-482) [AF 18(603)80]

Unclassified

Presented at 27th annual meeting of the Aero Med. Assoc., Chicago, Ill., Apr. 17, 1956.

Also published in Jour. Aviation Med., v. 27: 414-423, Oct. 1956.

Emission spectra of "dry" gas mixtures containing O_2 , N_2 , and CO_2 were studied using small-volume light sources in conjunction with monochromators employing a quartz prism (Beckman DU spectrophotometer) and a grating (Applied Research Laboratories quantograph) for light dispersion. Exploration of the calibration characteristics of the N_2 emission spectra produced with an rf excited quartz discharge tube revealed activity near 2372A which exhibited a near-linear relation between emission intensity and N_2 concentration. Photographic spectrograms were obtained between 5000-9000A using two light sources; namely, the positive column of a dc activated discharge tube and a rectangular quartz tube with external electrodes energized with rf. With both the dc and rf discharge tubes, O_2 emission was noted

as a triplet near 7772, 7774 and 7775A and as a singlet near 8446A. However, N_2 activity present with the dc light source operated at lower pressures was markedly suppressed at higher pressures when the rf emission tube was employed. The preliminary nature of the data is emphasized and the potential significance of the results are briefly discussed. (Contractor's abstract)

LOV.02:004

Lovelace Foundation for Medical Education and Research.
Depts. of Respiratory Physiology and Engineering,
Albuquerque, N. M.

EMISSION SPECTROSCOPY IN ANALYSIS OF RESPIRATORY GASES. IV. THE CALIBRATION CHARACTERISTICS OF OXYGEN EMISSION IN THE NEAR INFRARED, by C. S. White, L. C. Watkins, Jr., and E. E. Fletcher. May 1, 1957 [22]p. incl. illus. diagrs. tables. (AFOSR-TN-58-483) (AF 18(603)80)

Unclassified

Presented at 28th annual meeting of the Aero Med. Assoc., Denver, Colo., May 7, 1957.

Also published in Jour. Aviation Med., v. 28: 406-416, Aug. 1957.

A small volume, circular quartz discharge tube fitted with external metal electrodes is described which was adequate for energizing the O_2 triplet near 7772-75A and the O_2 singlet near 8446A. The operating characteristics of the discharge tube in terms of pressure, rf voltage, slit width and the relative emission noted with "dry" tank O_2 , CO_2 , N_2 and air in various combinations are presented. Calibration data are given for O_2 in N_2 which showed a curvilinear relation between emission intensity (at 7772-75A) and the higher concentrations of O_2 (100 to 20%), but the relation was linear at the lower O_2 concentrations (3 to 30%). Under similar conditions calibration figures for O_2 in CO_2 were linear up to 21% O_2 , but the curve fell below and was less steep than that for O_2 in N_2 . O_2 calibration in the presence of varying ratios of N_2 and CO_2 —obtained by diluting compressed air with CO_2 —was complex in that O_2 emission was apparently less than equal to and more than that for O_2 in N_2 when the O_2 concentrations were between 2-14, 14.5-16.5 and 17-20% respectively. (Contractor's abstract)

LOV.02:005

Lovelace Foundation for Medical Education and Research.
[Depts. of Respiratory Physiology and Engineering]
Albuquerque, N. M.

STUDY OF THE USE OF AUTOMATIC GAS ANALYSIS TO DETERMINE RESPIRATORY EFFICIENCY, by C. S. White, L. C. Watkins, Jr., and E. E. Fletcher. Final rept. Apr. 21, 1958 [30]p. incl. illus. diagrs. refs. (AFOSR-TR-58-58) (AF 18(603)80) AD 154295

Unclassified

A small circular quartz tube fitted with flat external

LYO.01:001 - LYO.01:003

metal electrodes and energized with an rf oscillator at 3.0 mc stabilized to minimize harmonics was employed as a light source on a Beckman DU spectrophotometer to explore the calibration characteristics of O_2 emission near 7772-7775Å. Calibration curves for up to almost 100% dry O_2 in N_2 were curvilinear; up to about 20% O_2 , the relation between emission output and O_2 concentration was essentially linear. The presence of dry CO_2 in dry O_2 - N_2 mixtures yielded complex calibration curves for O_2 whereby O_2 activity was enhanced and depressed by small and large amounts of CO_2 , respectively. A small rectangular quartz tube fitted with recessed flat rectangular external metal electrodes and energized with an rf oscillator at 3.0 mc was employed with the Beckman DU spectrophotometer to analyze CO_2 near 2896Å. Near this wavelength, the analyzer yielded linear curves for CO_2 mixtures in air, but was not specific for CO_2 in that N_2 effects were also noted. The analyzer was not judged adequate for routine use in respiratory physiology.

LYO.01:001

Lyons U. [Dept. of Physiology] (France).

[THE EFFECT OF CAFFEIN ON THE CEREBRAL ELECTRICAL ACTIVITY] Action de la caféine sur l'activité électrique cérébrale, by M. Juvet, O. Benoit and others. [1957] [4]p. incl. diagrs. [AF 61(514)1206] Unclassified

Published in Compt. Rend. Séances Soc. Biologie, v. 151: 1542-1545, July 8, 1957.

The encephalic preparation and isolated brain method, and the use of curarized preparations with flaxedil and the selective destructions of the central meso-diencephalic formations by means of coagulations are described. The EEG is recorded by screws fixed on the skull and subcortical structures by bipolar concentric electrodes oriented stereotactically. The level control of the trunk sections is treated by macroscopic examination, that of the coagulations by microscopic examination. The intravenous injection of 1 to 3 mg/kg of caffeine causes a rapid cortical and subcortical electrical activity of low voltage, a dose of 40 to 50 mg/kg causes a critical generalized epileptic activity. The injection of caffeine into a curarized animal institutes an important reduction of the cortical responses developed.

LYO.01:002

Lyons U. Dept. of Physiology (France).

[NEUROPHYSIOLOGICAL STUDY WITH MAN OF SOME SUBCORTICAL MECHANISMS OF ATTENTION] Etude neurophysiologique chez l'homme de quelques mécanismes sous corticaux de l'attention, by M. Juvet. [1957] [7]p. incl. illus. diagrs. refs. (AF 61-514)1206) Unclassified

Published in Psychol. Franc., v. 2: 254-260, Oct. 1957.

EEG and ventriculographic measurements were made on 9 subjects. Results indicated both the importance of the cortex in the attention process and that of the central reticular formations.

LYO.01:003

Lyons U. [Dept. of Physiology] (France).

[RESEARCHES ON THE ELECTRICAL ACTIVITY OF THE CEREBRUM DURING SLEEP] Recherches sur l'activité électrique cérébrale au cours du sommeil, by M. Juvet and F. Michel. [1958] [4]p. incl. diagrs. refs. (AF 61(514)1206) Unclassified

Published in Compt. Rend. Séances Soc. Biologie, v. 152: 1167-1170, July 7, 1958.

The chronic electrical activity of the sub-cortical meso-diencephalic formations and of the cortex for animals with an intact head, carriers of a section of the cerebral trunk and finally for cats with the cortex removed was studied. Observations are made for periods of one wk to three mos. Cortical and sub-cortical electrodes are implanted at the level of several cortical regions and meso-diencephalic formations, under barbital anaesthesia. A section of the cerebral column is tested for certain animals before the implantation by means of a blade oriented stereotactically. These relatively poikilothermal animals have their rectal temperature maintained at 38° by heating. The animals with the cortex removed are operated on for a time by the aspiration and coagulation of the neocortex. An acrylic resin prosthesis is located, from the frontal sinus to the occipital crest and the sub-cortical electrodes are fixed at its level. All the animals are tested in sound-proof cages. Histological controls verify the electrode situation, the extent of the cortical and cerebral trunk lesions.



MMU.01:016; MMU.02:001-004

MMU.01:016

McMaster U. Hamilton Coll., Ont. (Canada).

MASSSES OF ATOMS $A > 40$, H. E. Duckworth. July 1, 1957 [24]p. incl. tables, refs. (AFOSR-TN-57-322) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)484 and National Research Council of Canada) AD 132393 Unclassified

Also published in *Progress in Nuclear Phys.*, v. 6: 138-161, 1957.

Sources of atomic mass information which are discussed are: the mass spectroscopic atomic mass difference, the determination of the energy balance in nuclear reactions, total β -disintegration energies, determination of atomic masses by microwave spectroscopy, and α -disintegration energies. Discussions are included on the need for heavier standards, the requirements of heavier standards, suggested heavy secondary standards, and permanence of O^{16} as a primary standard. Atomic masses for $A > 40$ are tabulated.

MMU.02:001

McMaster U. Hamilton Coll., Ont. (Canada).

MASS SPECTROSCOPIC ATOMIC MASS DIFFERENCES. II, by H. E. Duckworth. Dec. 31, 1957 [6]p. incl. tables, refs. (AFOSR-TN-57-335) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)247 and National Research Council of Canada) AD 132409 Unclassified

Also published in *Rev. Modern Phys.*, v. 29: 767-772, Oct. 1957.

A brief description is given of the mass spectroscopic methods in current use for the determination of atomic masses. The agreement between atomic masses so derived and those obtained by studying the energy balance in nuclear reactions is also lightly touched upon, with particular reference to the mass of C^{12} . A table is given of the atomic mass differences which have been obtained mass spectroscopically during the past three years. (Contractor's abstract)

MMU.02:002

McMaster U. Hamilton Coll., Ont. (Canada).

THE LUMINESCENCE RESPONSE OF PHOSPHORS TO LOW ENERGY ION BOMBARDMENT, by C. F. Eve and H. E. Duckworth. [1958] [13]p. incl. diagrs. tables, refs. (AFOSR-TN-57-701) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-

247, Ontario Research Foundation, and National Research Council of Canada) AD 136694 Unclassified

Also published in *Canad. Jour. Phys.*, v. 36: 104-116, Jan. 1958.

The luminescence response of samples of $ZnS:Ag$ and $Zn_2SiO_4:Mn$ to bombardment with various ions was determined as a function of the ion energy E . For $ZnS:Ag$, within the range of ion energies studied ($E < 25$ kev), the luminescence response L is proportional to $(E - E_0)^m$ where E_0 is the threshold energy which is not a very sensitive function of the ion mass. For $Zn_2SiO_4:Mn$ no threshold energy was observed except in the case of Li^{7+} ions, the lightest ions used with this phosphor. The experimental results for $ZnS:Ag$ appear to be consistent with a theory in which it is assumed that the bombarding particles penetrate the phosphor as neutral atoms and produce luminescence by electronic excitation of the lattice atoms due to small impact parameter collisions.

MMU.02:003

McMaster U. Hamilton Coll., Ont. (Canada).

SOME RECENT MASS DETERMINATIONS AT McMASTER UNIVERSITY, by H. E. Duckworth, G. R. Bainbridge and others. [1957] [6]p. incl. diagrs. table, refs. (AFOSR-TN-58-66) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)247, National Research Council of Canada, and Shell Oil Co. of Canada) AD 148109 Unclassified

Also published in *Proc. Conf. on Nuclear Masses and Their Determination*, Max-Planck Institut für Chemie, Mainz (Germany) (July 10-12, 1956), London, Pergamon Press, 1957, p. 75-80.

The atomic masses of Ni^{58} and Ni^{60} have been determined by employing a double-focusing mass spectrometer using a doublet method. The values are larger than the previously accepted values but the Ni^{38} value agrees with a new measurement elsewhere. The effect of residual gas pressure in the spectrometer on the doublet spacing has been investigated and the results suggest that not all doublet spacings are pressure dependent.

MMU.02:004

McMaster U. Hamilton Coll., Ont. (Canada).

A LARGE SEMI-CIRCULAR MASS SPECTROMETER FOR ATOMIC MASS DETERMINATIONS, by H. E. Duckworth, J. T. Kerr, and G. R. Bainbridge. [1957] [3]p. incl. diagr. (AFOSR-TN-58-67) (Sponsored jointly by Air Force Office of Scientific Research under

MMU.02:005 - MMU.02:007

AF 49(638)247 and National Research Council of Canada) AD 148110 Unclassified

Also published in Proc. Conf. on Nuclear Masses and Their Determination, Max-Planck Institut für Chemie, Mainz (Germany) (July 10-12, 1956), London, Pergamon Press, 1957, p. 218-220.

The double-focusing mass spectrometer and its operation are briefly described. It consists of a semicircular magnetic analyzer and a $1/2 \pi$ analyzer. The instrument is essentially of the Dempster type, the difference being that the electrostatic analyzer is being used symmetrically. It is being constructed in 2 stages: first, the magnetic analyzer, and second, the electrostatic analyzer. The first analyzer has a radius of curvature of 9 ft. The magnetic field is established by 28 separate magnets positioned side by side to simulate a continuous semi-circular field. The vacuum chamber, a 4 in. by .75 in. Cu tube having a wall thickness of $1/8$ in., is capable of producing pressures approaching 10^{-7} mm Hg. A simple Nier-type electron-bombardment source is used. A feature of this magnetic analyzer is the fact that the magnetic field is both stabilized and swept by a proton moment mechanism. The position of each mass spectral peak is given by the frequency of the proton signal, and the doublet spacing is obtained in terms of a frequency difference. The performance of this analyzer is illustrated in a trace of the triplet consisting of singly-charged N_2O and CO_2 and triply-charged Xe^{132} . The second analyzer, now under construction, is made up of $1/2 \pi$ gold-plated condenser plates composed of Armco Fe, sitting end to end. The plates are 4 in. in depth, being separated by a 1-in. space. These plates are supported on insulators bedded on a large steel base plate to which is fastened a vacuum-tight Al lid. This lid connects at one end to the magnetic analyzer and at the other to the final ion collector. The pumping leads are also made through this lid.

MMU.02:005

McMaster U. Hamilton Coll., Ont. (Canada).

SECONDARY STANDARDS OF ATOMIC MASS FOR $A > 30$, by H. E. Duckworth. Oct. 1, 1957 [9]p. incl. illus. tables, refs. (AFOSR-TN-58-68) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)247 and National Research Council of Canada) AD 148111 Unclassified

Also published in Proc. Conf. on Nuclear Masses and Their Determination, Max-Planck Institut für Chemie, Mainz (Germany) (July 10-12, 1956), London, Pergamon Press, 1957, p. 245-252.

A series of 12 secondary mass standards has been obtained for the nuclei $A > 30$ by means of analysis of recent experimental results. The nuclei chosen as the standards have been suitably spaced throughout the mass

table and are relatively abundant and easily prepared for mass spectroscopic use. The experimental results used in computing the weighted mean are included in tabular form. The uncertainty in the results varies from approximately 1 kev for S^{32} to 100 kev for Th^{232} . The complete list of nuclei proposed to be used as atomic mass standards in the indicated range is: S^{32} , Ti^{48} , Zn^{64} , Kr^{84} , Pd^{104} , Sn^{120} , Xe^{132} , Nd^{144} , Dy^{164} , W^{196} , Pb^{208} and Th^{232} .

MMU.02:006

McMaster U. Hamilton Coll., Ont. (Canada).

ATOMIC MASSES OF Kr^{84} , Kr^{86} , Xe^{129} , Xe^{132} , Hg^{200} , Hg^{201} , AND Hg^{204} , by J. T. Kerr and H. E. Duckworth. Aug. 1, 1958, 3p. incl. refs. (AFOSR-TN-58-505) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)247 and National Research Council of Canada) AD 158313 Unclassified

Also published in Canad. Jour. Phys., v. 36: 986-988, July 1958.

The atomic masses of seven Kr, Xe and Hg isotopes have been determined by employing a large semicircular single-focusing mass spectrometer using a doublet method. Comparison with available results indicates that no serious systematic error exists. The uncertainties in the measured masses are approximately 100-200 kev. Using existing mass difference data it has been possible to calculate the mass value of the remaining stable mercury isotopes.

MMU.02:007

McMaster U. Hamilton Coll., Ont. (Canada).

SOME NEW ATOMIC MASS DETERMINATIONS MADE WITH A LARGE SINGLE-FOCUSING MASS SPECTROMETER, by J. T. Kerr, G. R. Bainbridge and others. [June 1958] [18]p. incl. diagrs. tables, refs. (AFOSR-TN-58-506) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)247] and National Research Council of Canada) AD 158317 Unclassified

Presented at Internat'l. Conf. on Mass Spectrometry, London (England), Sept. 24-26, 1958.

A large Dempster type double-focusing mass spectrometer has been constructed and is described. The magnetic analyzer portion of this spectrometer has been used as a single-focusing, semicircular mass spectrometer with which to make some atomic mass comparisons. The actual resolution of the instrument as determined in practice is about one part in 9000. A special beam modulation technique has been used to determine the atomic masses

MAD.01:001 - MAD.01:004

of Kr^{84} , Kr^{86} , ^{129}Xe , ^{132}Xe , Hg^{200} , Hg^{201} , and Hg^{204} (item no. MMU.02:006) with a precision of approximately one part in two million.

MAD.01:001

[Madrid U. Dept. of Crystallography (Spain).]

THERMAL VIBRATIONS IN DICARBOXYLIC ACIDS (Abstract), by J. L. Amorós and M. L. Canut. [1957] [2]p. [AF 61(514)1146] Unclassified

Presented at Internat'l. Union of Crystallography, Montreal (Canada), July 10-19, 1957.

Published in Acta Cryst., v. 10: 794-795, Dec. 10, 1957.

Diffuse scattering of succinic, adipic and pimelic acids has been studied to get information about motion of waves traveling along a chain-like structure. A complete recording of such diffuse scattering at room temperature was necessary and Lauegrams in a Unicam camera of 6 cm diameter were taken by steps 3° apart in a range of 180° since the recording was taken with [010] as the vertical axis. The diffuse domains have two main features: (a) broad, round, definite domains, corresponding to a zone in the reciprocal space of about 30° having a as medium axis; (b) fine, long, extended domains (streaks) corresponding to directions in the reciprocal space normal to c chain direction. Diffuse scattering was plotted in reciprocal space using Bernal and Martin charts. Two aspects of diffuse scattering domains are discussed in detail: (1) wave analysis of chain-like structures; and (2) thermal motion and symmetry. (Contractor's abstract, modified)

MAD.01:002

[Madrid U. Dept. of Crystallography (Spain).]

[STUDIES ON LATTICE DYNAMICS IN MOLECULAR CRYSTALS. V. DIRECT DETERMINATION OF THE THERMAL VIBRATION AMPLITUDE] Estudios acerca de la dinamica reticular en cristales moleculares. V. Determinación directa de la amplitud de la oscilación térmica, by J. L. Amorós, C. Belgrano, and M. L. Canut. [1957] [9]p. incl. diagrs. tables, refs. (AF 61-514)1146) Unclassified

Published in P. Dep. Crist. Min., v. 3: 5-13, 1957.

In order to get more information about thermal motion in crystals a systematic survey of the reciprocal space is developed, giving as a result an anisotropic $\langle f^2 \rangle$ normal and parallel to the chain direction. From this systematic survey it is possible to infer the nature of the thermal motion in a chain-like crystal. Making use of the Fourier transform

$$\rho_1 = \int_0^1 \langle f^2 \rangle e^{-2\pi i (hx)} dx$$

> 361 <

ρ_\perp and ρ_\parallel are readily calculated. Supposing an harmonic movement of the chain normal to the chain direction a new way has been developed by means of which it is possible to calculate u_\perp and u_\parallel . Values calculated by this method are consistent with the observed, giving a straightforward method for calculating thermal motion in crystals. (Contractor's abstract)

MAD.01:003

[Madrid U. Dept. of Crystallography (Spain).]

[STUDIES ON LATTICE DYNAMICS IN MOLECULAR CRYSTALS. VI. THERMAL DIFFUSE SCATTERING OF DICARBOXYLIC (EVEN) ACIDS: SUCCINIC AND ADIPIC ACIDS] Estudios acerca de la dinamica reticular en cristales moleculares. VI. Difracción difusa de los ácidos dicarboxílicos de la serie par: succínico y adipico, by M. L. Canut and J. L. Amorós. [1957] [11]p. incl. illus. diagrs. refs. (AF 61(514)1146) Unclassified

Published in P. Dep. Crist. Min., v. 3: 15-25, 1957.

Diffuse scattering of succinic and adipic acids was studied to get information about motion of waves traveling along a chain-like structure. A complete recording of such diffuse scattering at room temperature was necessary and Laue photographs in a Unicam camera 6 cm diameter were taken in a range of 180° as the recording was taken with [010] as vertical axis. The diffuse domains are of two main types: (a) broad, round, definite domains, corresponding to a region in the reciprocal space of about 30° having a as medium axis; (b) fine, long, extended domains (= streaks) corresponding to directions in the reciprocal space normal to chain direction. Diffuse scattering was plotted in reciprocal space using Bernal and Martin charts. Special features of the diffuse scattering domains are noted. Results are discussed in terms of wave analysis of chain-like structures and of thermal motion and symmetry. (Contractor's abstract, modified)

MAD.01:004

[Madrid U. Dept. of Crystallography (Spain).]

[STUDIES ON LATTICE DYNAMICS IN MOLECULAR CRYSTALS. VII. THERMAL DIFFUSE SCATTERING OF DICARBOXYLIC (ODD) ACIDS: PIMELIC ACID] Estudios acerca de la dinamica reticular en cristales moleculares. VII. Difracción difusa de los ácidos dicarboxílicos de la serie impar: pimélico, by M. L. Canut and J. L. Amorós. [1957] [5]p. incl. illus. diagrs. (AF 61(514)1146) Unclassified

Published in P. Dep. Crist. Min., v. 3: 27-31, 1957.

Diffuse scattering of pimelic acid was studied to get

MAD.01:005 - MAD.01:008

information about motion of waves traveling along a chain-like structure. The method used is the same as that for item no. MAD.01:003. Results are discussed in terms of wave analysis of chain-like structures and of thermal motion and symmetry.

MAD.01:005

Madrid U. Dept. of Crystallography (Spain).

STUDIES OF THERMAL MOTION IN CRYSTALS, by J. L. Amorós, M. L. Canut and A. Bujosa. Annual rept. no. 1, Dec. 15, 1956 - Dec. 15, 1957, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-154) (AF 61(514)-1146) AD 152180 Unclassified

Thermal motion of atoms in the dicarboxylic acids series was studied. A new method was developed for making a direct determination of molecular movement from a systematic analysis of the reciprocal lattice. Methods employing the electron density of a crystal were investigated, especially those based on $(F_o - F_c)$ Fourier synthesis. Several features relating densities and amplitudes were discovered. Diffuse scattering of a chain-like crystal was studied in β -succinic, adipic, sebacic, glutaric, and pimelic acids. Continuous diffuse scattering domains were characteristic of such diffuse scattering. Symmetry requirements for both atomic and wave motion in crystals were examined, and differences between static and dynamical space groups were emphasized. A comparison was made between diffuse scattering and both crystal expansion and polymorphism in an effort to evaluate the influence of atom motion in crystal motion (ASTIA abstract)

MAD.01:006

Madrid U. Dept. of Crystallography (Spain).

[APPLICATION OF THE FOURIER TRANSFORM TO THE STUDY OF THERMAL DIFFUSE SCATTERING OF MOLECULAR CRYSTALS] Aplicación de la transformada de Fourier al estudio de la difracción difusa térmica de cristales moleculares, by J. L. Amorós and M. L. Canut. [1958] [17]p. incl. diagrs. refs. (AF 61-514)1146) Unclassified

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 56: 305-322, 1958.

Also published in P. Dep. Crist. Min., v. 6, 1959-60.

The method of using the Fourier transform in the author's investigations is described. Application is shown for crystals of succinic and adipic acids. The difference Fourier transform method is shown to be superior to both the Fourier transform corresponding to the rest condition and to the latter corrected for thermal motion.

MAD.01:007

Madrid U. Dept. of Crystallography (Spain).

INTERPRETATION OF THE EXTENDED CONTINUOUS REGIONS OF X-RAY THERMAL DIFFUSE SCATTERING OF MOLECULAR CRYSTALS, by J. L. Amorós, M. L. Canut and others. [1958] 70p. incl. illus. diagrs. refs. (Bound with its AFOSR-TR-59-47; AD 215061) 61-514)1146) Unclassified

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., 1959.

Also published in P. Dep. Crist. Min., v. 5, 1958.

Also published in Zeitschr. Krist., v. 114: 39-65, June 1960.

The weak extended continuous regions of x-ray thermal diffuse scattering of molecular crystals of different structural types are interpreted in terms of a new function, the difference Fourier transform (DFT) of the molecules. The experimental thermal diffuse scattering of adipic acid, succinic acid, hexamine, naphthalene and anthracene is compared with the isodiffusion lines computed with the DFT. The good agreement between theoretical and experimental values shows that DFT is a good approach to the interpretation of such continuous diffuse regions in molecular crystals and that independent (or antiphase) movement of the molecules as rigid bodies accounts for the morphology of such continuous regions of diffuse scattering. (Contractor's abstract)

MAD.01:008

Madrid U. Dept. of Crystallography (Spain).

[LATTICE DYNAMICS IN IONIC CRYSTALS. I. DIFFUSE SCATTERING OF THE POLYMORPHIC FORMS IV - (-18°C TO 32°C) AND III - (32°C TO 84°C) AMMONIUM NITRATE] Dinámica de redes en cristales iónicos. I. Difracción difusa de las formas polimórficas IV (entre -18°C y 32°C) y III (entre 32°C y 84°C) del nitrato amónico, by P. Alonso, M. L. Canut, and J. L. Amorós. [1958] [15]p. incl. illus. diagrs. refs. (AF 61(514)1146) Unclassified

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 56: 51-64, 1958.

Also published in P. Dep. Crist. Min., v. 4: 23-29, 1958.

The structure is reviewed of forms IV and III. Experimental results of an x-ray diffuse scattering study are presented with Laue photographs and distributions of the diffuse scattering domains. In form IV high frequency vibrations are very clear, that is, optical frequencies characteristic of atomic groups vibrating as rigid bodies. But in form III the thermal diffuse scattering indicates that acoustical frequencies contribute

MAD.01:009 - MAD.01:013

mainly to the vibrational spectrum. The apparent paradoxical diminution of thermal diffuse scattering at higher temperature is seen as a consequence of the structural change from form IV to form III.

MAD.01:009

Madrid U. Dept. of Crystallography (Spain).

[LATTICE DYNAMICS IN MOLECULAR CRYSTALS. VIII. THERMAL DIFFUSE SCATTERING OF HEXAMINE $C_6H_{12}N_4$] Dinámica de redes en cristales moleculares. VIII. Difracción difusa térmica de la hexamina, $C_6H_{12}N_4$, by M. L. Canut and J. L. Amorós. [1958] [16]p. incl. illus. diagrs. refs. [AF 61(514)1146] Unclassified

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 56: 323-338, 1958.

An experimental x-ray analysis was made using Laue photographs. Diffuse scattering domains are analyzed for plane 001 at levels of 0, 1/2, 1, 3/2 and 2. The domains are also analyzed tridimensionally. The diffuse scattering data are discussed briefly in relation to atomic vibration, molecular morphology and wave propagation. The static and dynamic spatial groups of the crystal are different, and an explanation of this is given.

MAD.01:010

Madrid U. Dept. of Crystallography (Spain).

[LATTICE DYNAMICS IN MOLECULAR CRYSTALS. IX. THERMAL DIFFUSE SCATTERING OF PENTAERYTHRITOL] Dinámica de redes en cristales moleculares. IX. Difracción difusa térmica en el pentaeritritol, by P. Alonso, M. L. Canut, and J. L. Amorós. [1958] [12]p. incl. illus. diagrs. [AF 61(514)-1146] Unclassified

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 56: 379-390, 1958.

An experimental x-ray study was made using a prismatic crystal and Laue photography with a Unicam camera and a cylindrical film holder of 60 mm diameter. Copper filtered radiation was used from a Philips tube operated at 40 kv and 20 mA with 2 hr exposure. Diffuse scattering domains are analyzed for the 001 plane at 0, 1, 2, and 3 levels and analyzed also tridimensionally. The diffuse scattering data are discussed in relation to atomic vibration, wave propagation and structure. Torsional oscillations probably occur in pentaerythritol.

MAD.01:011

Madrid U. Dept. of Crystallography (Spain).

[LATTICE DYNAMICS IN MOLECULAR CRYSTALS. X. THERMAL SCATTERING OF NAPHTHALENE] Dinámica de redes en cristales moleculares. X. Difracción difusa térmica del naftaleno, by A. de Acha, M. L. Canut, and J. L. Amorós. [1958] [14]p. incl. illus. diagrs. refs. [AF 61(514)1146] Unclassified

Presented at Twenty-fourth Luso-Spanish Congress of the Assoc. for the Progress of Science, Madrid (Spain), Nov. 14-20, 1958.

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 56: 405-418, 1958.

Experimental results are given for an x-ray study using Laue photographs. Diffuse scattering domains are analyzed for plane 010 at levels 0, 1/2, 1, 3/2 and 2 and analyzed also tridimensionally. The diffuse scattering results are discussed in relation to structure, symmetry, vibration and wave propagation.

MAD.01:012

Madrid U. Dept. of Crystallography (Spain).

[LOGICAL INTERPRETATION OF THE LAUEDIAGRAMS] Interpretación racional de los lauediagramas, by M. L. Canut and J. L. Amorós. [1958] [11]p. incl. diagrs. [AF 61(514)1146] Unclassified

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 56: 15-24, 1958.

Also published in P. Dep. Crist. Min., v. 4: 1-6, 1958.

A general discussion is given on the logical interpretation of Laue x-ray photographs. The three types of Laue photographs — cylindrical, flat back reflection and flat back transmission — are separately considered and then comparison is made of their stereographic projections. The cylindrical Laue photograph in combination with stereographic projection is favored for crystal morphology studies.

MAD.01:013

Madrid U. Dept. of Crystallography (Spain).

[POLYMORPHIC TRANSITIONS IN SINGLE CRYSTALS. I. SUPERSTRUCTURE FORMATION IN THE IV - V (-18°C) TRANSITION OF AMMONIUM NITRATE] Transformaciones polimórficas en monocristales. I. Formación de superestructura en la transición IV - V (-18°C) del nitrato amónico, by J. L. Amorós, P. Alonso, and M. L. Canut. [1958] [11]p. incl. illus. diagrs. [AF 61(514)1146] Unclassified

MAD. 01:014, 015; MAD. 02:001;
MAR. 02:001

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 56:
65-75, 1958.

Also published in P. Dep. Crist. Min., v. 4: 30-37, 1958.

Laue photographs were taken at room and successively lower temperatures down to -85°C as the basis of this x-ray analysis study of the transition. No further transition from form V occurred at -80°C as had been suggested by specific heat studies. Diffuse scattering decreased very much in the low temperature form V while Laue spots increased both in number and intensity. Form V is found to belong to the tetragonal class, while modification IV has orthorhombic symmetry. Rotation photographs at low temperature show superstructure lines midway between levels of the corresponding room temperature photographs. The unit cell volume of V is 8 times that of IV. The transformation IV - V is reversible. In principle the mechanism of the transition can be explained on the basis of the superstructure formation but certain details fall outside of this formation phenomenon.

MAD.01:014

Madrid U. Dept. of Crystallography (Spain).

[POLYMORPHIC TRANSITIONS IN SINGLE CRYSTALS. II. IV - II-AMMONIUM NITRATE (84°C) TRANSITION AND II' (55°C) METASTABLE FORM] Transformaciones polimórficas en monocristales. II. Transición IV-II (84°C) del nitrato amónico y forma metaestable II' (55°C), by J. L. Amorós, P. Alonso, and M. L. Canut. [1958] [15]p. incl. illus. diagrs. [AF 81(514)1148] Unclassified

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 58:
77-91, 1958.

Also published in P. Dep. Crist. Min., v. 4: 38-45, 1958.

Form II is obtained by heating form IV suddenly over the transition point 84°C , but by heating IV directly to 55°C the metastable II' results. Experimental results are given for an x-ray analysis of these transitions. Lattice constants are the same for both forms, II and II', $a = 5.68\text{\AA}$ and $c = 4.92\text{\AA}$. The space group for II is $P4bm$ and for II' seems to be $P4$. The conclusion is reached that the production of disorder inherent in the jump from form IV to II can be obtained only by very quick heating. Less heating results in the metastable II' phase, but if the crystal receives enough energy, the transition to II is definitive.

MAD.01:015

Madrid U. Dept. of Crystallography (Spain).

[THERMAL WAVES IN CHAIN STRUCTURES] Ondas térmicas en cristales en cadenas, by J. L. Amorós and

M. L. Canut. [1958] [26]p. incl. illus. diagrs. table, refs. (AF 61(514)1146) Unclassified

Published in Bol. R. Soc. Esp. Hist. Nat. (G), v. 58:
25-50, 1958.

Also published in P. Dep. Crist. Min., v. 4: 7-22, 1958.

The subject is discussed in a general manner with emphasis on experimental work done in the authors' lab. In the study of thermal motion the technique of x-ray diffuse scattering is used on crystals with a chain-like structure. Dicarboxylic acids, both even and odd, have been studied. Structural characteristics are reviewed of the experimental crystals, and the experimental method is described. New data on thermal diffuse scattering domains are furnished for suberic and glutaric acids. Results are interpreted in relation to the propagation of waves in function of crystal structure and in relation to crystal symmetry.

MAD.02:001

Madrid U. [Instituto de Calculo] (Spain).

[SEMIANALYTIC CLASSES IN CONVEX REGIONS] Classes semi-analytiques dans des régions convexes, by M. R. San Juan. Technical summary rept. Mar. 1-June 1, 1957, 6p. (AFOSR-TN-57-383) (AF 81(514)1254) AD 132435 Unclassified

Also published in Compt. Rend. Séances Acad. Sci., v. 245: 292-294, Jan. 14, 1957.

The results given by the author at the International Congress of Mathematics at Amsterdam in 1954 on the semi-analytic classes have been generalized at one and the same time to apply to convex regions and to the transformation of the exponential functions to the domain Δ_s of M. Mandelbrojt. (Contractor's abstract)

Mallinckrodt Chemical Lab., Cambridge, Mass.
see Harvard U. Mallinckrodt Chemical Lab.,
Cambridge, Mass.

MAR.02:001

Marseille U. Inst. of Fluid Mechanics (France).

EXPERIMENTAL INVESTIGATION OF THE ROTATING STALL IN A SINGLE STAGE AXIAL COMPRESSOR, by J. Valensi. [1957] [27]p. incl. illus. diagrs. table, refs. (AF 61(514)1030) Unclassified

Presented at Twenty-fifth annual meeting of the Inst. Aeronaut. Sciences, New York, Jan. 28-31, 1957.

Investigations have been made of the rotating stall flow

MAR.02:002; MRT.01:001;
MDU.01:002-004

pattern on a single stage axial compressor, by means of dynamic stagnation and static pressure measurements and of smoke surveys. Both techniques yield results which are in good agreement. Smoke surveys appear to be of great assistance in the explanation of the rotating stall mechanism. (Contractor's abstract)

MDU.01:002

Maryland U. Dept. of Mathematics, College Park.

QUASI INTERIOR POINTS OF CONES IN A LINEAR SPACE, by R. E. Fullerton. Feb. 1957, 16p. incl. diagrs. (AFOSR-TN-57-65) (AF 18(603)78) AD 120406

Unclassified

A topological definition of a quasi interior point of a cone in a linear topological space is given. If the cone has a non-void interior it is shown that all quasi interior points are interior points and that furthermore in L spaces and other commonly considered function and sequence spaces the notion of a quasi interior point coincides with the notion of a strictly-positive element of the space. Various geometric properties of quasi interior points of cones are proved to hold and in particular in section 5 certain separation and support properties of such sets are proved.

MDU.01:003

Maryland U. Dept. of Mathematics, College Park.

GEOMETRICAL CHARACTERIZATIONS OF BIORTHOGONAL BASIS SYSTEMS IN A BANACH SPACE, by R. E. Fullerton. July 1957, 17p. (AFOSR-TN-57-426) (AF 18(603)78) AD 136415

Unclassified

Proof is given that the existence of a certain type of cone in a Banach space is a necessary and sufficient condition for the existence of a biorthogonal basis system. The cone is named a biorthogonal basis cone and its properties are investigated. Most of the properties enumerated hold for bases in convex linear topological spaces and do not have to be formulated in terms of a norm topology. These considerations can be applied to the investigations of properties and characterizations of generalized biorthogonal basis systems by removing countability restrictions in certain of the assumptions.

MDU.01:004

Maryland U. Dept. of Mathematics, College Park.

SET FUNCTIONS AND TRANSLATION HALF-RINGS IN THE PLANE, by P. H. Maserick. Nov. 1957, 8p. (AFOSR-TN-57-764) (AF 18(603)78) AD 136754

Unclassified

Presented at Sixty-fourth annual meeting of the Amer. Math. Soc., Cincinnati, Ohio, Jan. 28-30, 1958.

Also published in Proc. Amer. Math. Soc., v. 10: 133-139, Feb. 1959. (Title varies)

The properties of half rings as introduced by Von Neumann are studied in an E^2 with a metric group structure. A translation half ring (t.h.r.) in E^2 is a half ring

MAR.02:002

Marseille U. Inst. of Fluid Mechanics (France).

SECONDARY FLOWS IN AN AXIAL COMPRESSOR, by J. Valensi. Final rept. Nov. 8, 1957, 1v. incl. illus. diagrs. refs. (AFOSR-TR-58-40) (AF 61(514)1030; continuation of AF 61(514)425) AD 154123; PB 214658

Unclassified

An investigation of secondary flow effects, near the walls and through the blade passages of an axial compressor, and depiction of the mean flow have been made by means of smoke visualization. Vorticity distribution is analyzed both theoretically and experimentally. Analyses of the rotating stall flow pattern on a single stage axial compressor are made by means of dynamic stagnation, static pressure measurements, and smoke surveys. The results of both techniques are in good agreement. Smoke surveys appear to be of great assistance in the explanation of the rotating stall mechanism. They give clear evidence of the three-dimensional pattern of the phenomenon which might be a determinant factor for the different characteristics of rotating stall.

MRT.01:001

Martin [Glenn L.] Co., Baltimore, Md.

FLUTTER OF THIN PANELS AT SUBSONIC AND SUPERSONIC SPEEDS, by J. E. Greenspan and R. L. Goldman. July 1957, 1v. incl. illus. tables, refs. (Engineering rept. no. 9934) (AFOSR-TR-57-65) (AF 18(603)78) AD 136560; PB 132506

Unclassified

The flutter behavior of thin-skin panels was investigated in subsonic and supersonic flow. Experiments indicated that subsonic skin-flutter is possible. The subsonic and, to some extent, the supersonic flutter of finite skin panels is a periodical interchange between quasistatic shapes of the skin and is more complex than was assumed. A simple phenomenological analysis was developed on the basis of possible static shapes (for the membrane case) and yields qualitative agreement with the experimental results for the subsonic case. Flutter is self-limited in amplitude and is not necessarily destructive. A speech is included which was given by P. F. Jordan and E. Widmayer on Some Experiments On Panel Flutter at the Second Technical Symposium on Ballistic Missiles at the Ramo-Wooldridge Corp. (ASTIA abstract)

MDU.01:005 - MDU.01:009

\mathcal{L} such that if $R \in \mathcal{L}$ and R^* is a translate of R , then $R^* \in \mathcal{L}$. A half ring \mathcal{L} which generates the class of all Borel sets in E^2 is called a non-degenerate half ring (n-d t.h.r.). The following theorems have been demonstrated: (1) the set P of all convex polygons forms a planar half ring; (2) a n-d t.h.r. P of convex polygons has a finite number of directions if and only if there exists a number m such that each $p \in P$ has less than m sides; (3) if P is a n-d t.h.r. of convex polygons, then for every pair of distinct directions of P , P contains a non-degenerate rhombus oriented with respect to these directions; (4) if H is a n-d t.h.r. of bounded convex sets in the plane, then each $h \in H$ is a convex polygon; and (5) if P is a n-d t.h.r., then I (a real valued set function defined on P) is proportional to the Lebesgue measure on P and the extension I' of I is proportional to the Lebesgue measure on the Borel sets in E^2 .

MDU.01:005

Maryland U. Dept. of Mathematics, College Park.

AN INTERSECTION PROPERTY FOR CONES IN A LINEAR SPACE, by R. E. Fullerton. Nov. 1957, 6p. (AFOSR-TN-57-765) (AF 18(603)78) AD 136755
Unclassified

Also published in Proc. Amer. Math. Soc., v. 9: 558-561, Aug. 1958.

It has previously been shown that if X is a real linear space with a very rudimentary topology, and if F is the family of all translates of a set C with an extreme point such that the intersection of any two set in F is another set in F , then C is a convex cone. A partial converse of the above is given in this paper. It is shown that if C is a cone and if $x, y \in X$ exist such that $(x+C) \cap (y+C)$ is a cone K , then there exists a $z \in X$ such that $K = z+C$. Examples of cones C having this property are discussed.

MDU.01:006

Maryland U. Dept. of Mathematics, College Park.

ON A CLASS OF TOPOLOGIES FOR FIELDS, by E. Correl. Feb. 1958, 10p. (AFOSR-TN-58-198) (AF 18(603)78) AD 152231
Unclassified

Locally compact topological fields are systematically studied and determined. A class of field topologies is examined which arises from l.c. topologies. A key definition says that a topology t for a field F is called l.c. if F together with t is a dense subfield of a non-discrete, non-indiscrete, locally compact topological field. The collection of all l.c. topologies for a field F generates a set J of field topologies for F , the set of all join topologies. The relation between an element of J and an arbitrary field topology for F is considered. Various definitions and lemmas are given and proved.

MDU.01:007

Maryland U. Dept. of Mathematics, College Park.

TOPOLOGICAL STRUCTURES FOR A SPACE OF CONTINUOUS FUNCTIONS, by R. E. McGill. June 1958, 25p. incl. diagrs. table. (AFOSR-TN-58-548) (AF 18(603)78) AD 158365
Unclassified

A discussion is presented of the properties and relationships of 7 topologies on the linear space of real valued continuous functions defined on the closed unit interval. The theory of quasi-convergence classes is developed in order to have a unified method for defining many of the topologies. Along with such properties as the relative strength, linearity, and semi-linearity of the topologies, topologies are given which coincide with the original topologies on either the weakly compact, uniformly bounded, or equi-continuous subsets of the function space. (Contractor's abstract)

MDU.01:008

Maryland U. Dept. of Mathematics, College Park.

ALMOST UNIFORM CONVERGENCE VERSUS POINTWISE CONVERGENCE, by J. W. Brace. Aug. 1958, 6p. (AFOSR-TN-58-799) (AF 18(603)78) AD 202232; PB 138063
Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 986-987, Dec. 1960.

It has been established that the topology of almost uniform convergence on the collection of all bounded continuous real valued functions over a completely regular Hausdorff space is equivalent to the topology of pointwise convergence of the extended functions over the Stone Cech compactification (MDU.01:001). This raises the question as to when almost uniform convergence of a net of functions is equivalent to pointwise convergence of a net of extended functions over an enlargement of the original domain. This paper answers the question within certain restrictions.

MDU.01:009

Maryland U. Dept. of Mathematics, College Park.

OPERATORS AND THEIR FREDHOLM DOMAIN, by J. W. Brace. Sept. 1958 [23]p. incl. refs. (AFOSR-TN-58-851) (AF 18(603)78) AD 203492
Unclassified

The operator $1-\lambda T$, with λ a complex number, 1 the identity mapping, T a closed linear operator taking a Banach space X into itself, is taken. The purpose is a solution $x - \lambda T x = y$ for x , for a given y in X . A set of complex numbers called the generalized Fredholm domain for T is presented along with appropriate generalizations of the definition of the Fredholm radius. A

MDU.02:016 -MDU.02:019

general class of operators having the spectral properties of compact operators is given, and a method analogous to the Fredholm method for integral equations is given applicable to the Fredholm domain of type I. A reverse method for determining information on eigenvalues is discussed. Further work is commented upon.

MDU.02:016

Maryland U. Dept. of Physics, College Park.

LATTICE VIBRATIONS IN SODIUM CHLORIDE TYPE STRUCTURES, by P. Mazur. [1957] 121p. incl. diagrs. refs. (Technical rept. no. 65) (AFOSR-TN-57-149) (AF 18(600)1015) AD 126438 Unclassified

Three problems in the theory of lattice vibrations in sodium chloride type lattices are investigated and quantitative treatments are carried out in detail. Firstly, assuming only nearest neighbor interactions with central and noncentral forces, the frequency spectrum (i.e., the number of normal modes of vibration between ω^2 and $\omega^2 + \Delta\omega^2$) is obtained exactly. The effect of 2nd nearest neighbor interactions on the spectrum is then treated as a small perturbation. Secondly, assuming only nearest neighbor interactions, the distribution function of the position of a typical atom around its equilibrium position is worked out. Analytic expressions for the dispersion are obtained as a function of temperature, central and non-central force constants, M (the heavier mass component), and m (the lighter mass component). Thirdly, the effect of defects on the lattice vibration is investigated. Depending on the type of defect introduced one finds localized modes emerging from either the acoustical band or the optical band or both. The self-energy of one isotope defect and the interaction energy between two isotope defects is obtained only for a one dimensional diatomic chain. The localized modes arising in the case of a three dimensional diatomic lattice (sodium chloride type) are examined only qualitatively from the Green's Function for the problem. (Contractor's abstract)

MDU.02:017

Maryland U. Dept. of Physics, College Park.

EFFECT OF DEFECTS ON THE VIBRATION OF CRYSTAL LATTICES, by E. W. Montroll, A. A. Maradudin, and G. H. Weiss. June 1957, 26p. diagrs. refs. (Technical rept. no. 76) (AFOSR-TN-57-364) (AF 18(600)-1015 and AF 18(600)1315) AD 132436 Unclassified

Presented at Many Body Conf., Hoboken, N. J., Feb. 1957.

The effect of defects on the vibrational properties of crystal lattices is discussed qualitatively and quantitatively. A general method is presented for calculating the change in additive functions of the normal mode frequencies due to the presence of defects in the lattice. By an extension of this method one can calculate the frequencies of the localized modes of vibration associated with the defects. The theory is applied to the calculation of the frequencies of the localized modes due to impurity atoms in a linear chain, and also to the calculation of frequency splitting due to the presence of defect pairs. The change in the Helmholtz free energy and specific heat of a lattice due to the presence of a single defect is evaluated in the high temperature limit. An expression for the interaction energy between two isotope defects as a function of their separation at high temperatures is also given. Finally a method is presented for evaluating the effect of a large number of defects on additive functions of the normal mode frequencies. The method is illustrated by a calculation of the zero point energy of a disordered binary linear chain. (Contractor's abstract)

MDU.02:018

Maryland U. Dept. of Physics, College Park.

THEORY OF THE VIBRATIONS OF DISORDERED CRYSTAL LATTICES, by A. [A.] Maradudin and G. H. Weiss. [1958] [55]p. incl. diagrs. table, refs. (Technical rept. no. 79) (AFOSR-TN-57-365) (AF 18(600)1015 and AF 18(600)1315) AD 132437 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series 11, v. 3: 233, May 1, 1958. (Title varies)

A new method is presented for evaluating various additive functions of the normal mode frequencies for a lattice made up of different kinds of atoms which are randomly distributed over the lattice sites. This method, which is based on an expansion of the additive function expressed as a contour integral, is applied to the case where the lattice is made up of atoms with two different masses M_1 and M_2 which are present with probabilities p and $(1-p)$ respectively. Conditions under which the expansion converges are given for this case. The method is illustrated by some simple examples, and its generalization to more general disordered lattices is discussed. (Contractor's abstract)

MDU.02:019

Maryland U. Dept. of Physics, College Park.

QUANTUM STATISTICS OF INTERACTING PARTICLES. GENERAL THEORY AND SOME REMARKS ON PROPERTIES OF AN ELECTRON GAS, by E. W. Montroll and

MDU.02:020 - MDU.02:022

J. C. Ward. Sept. 1957, 1v. Incl. diagrs. refs. (Technical rept. no. 88) (AFOSR-TN-57-599) (AF 18(600)-1015) AD 136585
Unclassified

Presented at Internat'l. Convention on Condensed States in Simple Systems, Varenna (Italy), Sept. 11-15, 1957.

Abstract published in Nuovo Cimento, Series X, Suppl., v. 9: 235-236, 1958.

Also published in Phys. Fluids, v. 1: 55-72, Jan-Feb. 1958.

A systematic generalization of the Mayer cluster integral theory has been developed to deal with the quantum statistics of interacting particles. The grand partition function appears in a natural way and the cluster integrals are integrals over propagators which are derived from the Green's function solution of the Bloch equation. Every cluster integral can be represented by a hybrid of a Mayer graph and a Feynman diagram. The indistinguishability of particles causes each particle in a Mayer cluster integral to be replaced by a toron which can be described in the following manner through a Feynman diagram. Consider an (r, β) space in the form of a torus of tubal circumference β . A toron of order n is represented by a closed path which loops the torus n times so that a cut at constant β' (with $0 < \beta' < \beta = 1/kT$) on the torus identifies the position of n particles at β' . In the absence of a cut there is no indication of where one particle ends and another begins. The grand partition function is a sum over all graphs in which torons are connected by interaction lines which represent quanta of energy and momentum exchanged through collisions. The cluster integrals associated with rings of torons have been analyzed. In the case of electron gas the classical limit of the contribution of these integrals to the grand partition function yields the Debye-Hückel theory, while the low temperature limit leads to the Gell-Mann Brueckner equation for the correlation energy of the grand state. The construction of the cluster integral associated with any given diagram is explained. (Contractor's abstract)

MDU.02:020

Maryland U. Dept. of Physics, College Park.

A STUDY OF SOME LANCHESTER-LIKE EQUATIONS, by A. [A.] Maradudin and G. [H.] Weiss. [1958] [9]p. Incl. diagr. (Technical rept. no. 95) (AFOSR-TN-58-267) (AF 18(600)1015 and AF 18(600)1315)
AD 154168
Unclassified

A set of phenomenological equations, formulated to describe land warfare for the case when there is no resupply of troops, is presented. These equations resemble those of ecological studies. A set of birth-and-death equations is studied whose expected values satisfy the proposed phenomenological equations. These equations are used to study approximately the probability

that either side will reduce the forces of its opponent to zero.

MDU.02:021

Maryland U. Dept. of Physics, College Park.

SCREW DISLOCATIONS AND DISCRETE ELASTIC THEORY, by A. A. Maradudin. [1958] 42p. Incl. diagrs. tables, refs. (Technical rept. no. 105) (AFOSR-TN-58-390) (AF 18(600)1015) AD 154299
Unclassified

Also published in Jour. Phys. Chem. Solids, v. 9: 1-20, Jan. 1959.

A simple model of a screw dislocation in a crystal lattice is presented. The lattice is assumed to be such that each atom interacts with its neighbors by means of Hooke's law type forces. Expressions for the displacement component and the strain energy are obtained. Applications of the model to screw dislocations in alkali-halide crystals are discussed.

MDU.02:022

Maryland U. Dept. of Physics, College Park.

VIBRATIONAL THERMODYNAMIC PROPERTIES OF LATTICES WITH DEFECTS. I. THE LINEAR LATTICE, by J. Mahanty, A. A. Maradudin, and G. H. Weiss. [1958] 45p. Incl. diagrs. (Technical rept. no. 104) (AFOSR-TN-58-391) (AF 18(600)1015 and AF 18(600)-1315) AD 154300
Unclassified

Also published in Prog. Theoret. Phys., v. 20: 369-394, Sept. 1958.

Several methods of analyzing vibrational properties of crystal lattices with defects are developed. Integral expressions for additive functions of normal mode frequencies are derived following the work of Montroll and his collaborators. It is shown that the Helmholtz free energy can be evaluated at high and low temperatures without performing the integrations. The methods presented are valid for lattices of all dimensions, although specific results are presented here for one-dimensional monatomic and diatomic lattices. Using a method similar to that developed by Lifshitz, it is shown that the properties of a lattice with defects can be expanded in a series of powers of the concentration of defects. The coefficient of the n^{th} power depends on the properties of a lattice with no defects. Examples of such expansions are given. An exact expression for the frequency distribution function of a monatomic linear chain with an isotope defect is given. (Contractor's abstract)

MDU.02:023 - MDU.02:026

MDU.02:023

Maryland U. Dept. of Physics, College Park.

VIBRATIONAL FREQUENCY SPECTRA OF DIS-ORDERED LATTICES. I. THE LINEAR CHAIN, by C. Domb, A. A. Maradudin and others. [Nov. 1958] 68p. Incl. diagrs. refs. (Technical rept. no. 118) (AFOSR-TN-58-981) (AF 18(600)1015) AD 261542

Unclassified

Also published in Phys. Rev., v. 115: 18-24, July 1, 1959. (Title varies)

The Moment-Trace method has been used to compute the vibrational frequency spectrum of a randomly disordered, two-component, isotopic linear chain in terms of a wide range for the concentrations of the two kinds of particles and for the ratio of the masses of the particles. With the aid of the theory of random walks on lattices a combinatorial expression for the even moments of the spectrum has been obtained and has been used to calculate the moments up to $n = 20$. In addition, it has been possible to treat exactly the particular case of a chain in which the mass of one of the isotopic constituents becomes infinite, and the results of this calculation have shed light on the form of the spectra for lattices with large but finite mass ratios for the two constituents. The spectra are characterized by the disappearance of the square-root singularity at the maximum frequency which is found in ordered one-dimensional lattices, and by the appearance of impurity bands. The nature of these impurity bands is discussed. (Contractor's abstract, modified)

MDU.02:024

Maryland U. Dept. of Physics, College Park.

SOLID STATE THEORY. Final rept. Oct. 1958, 7p. Incl. refs. (AFOSR-TR-58-147) (AF 18(600)1015) AD 205094; PB 137932

Unclassified

The problem of the propagation of waves in periodic media was studied. Details of the distribution functions of normal mode frequencies were investigated for several models of monatomic lattices and diatomic lattices. The effects of impurities on lattice vibrations and how these influence the thermodynamic properties are described. The use of Green's functions was explored. The exploitation of the relationship between the moments of a frequency distribution and random walks has been developed. The local behavior of atoms in a vibrating lattice has been examined and expressions found for the displacement of a given atom from its equilibrium position and for the cancellation of displacements of neighboring atoms. The method of spin waves has been applied to the problem of low temperature ferromagnetism of binary alloys. Anharmonicity was investigated in the simple case of a triatomic molecule

and the results are given. Detailed numerical calculations were started on ferroelectricity and also a collective electron treatment of ferro and anti-ferromagnetism in a two dimensional lattice. The Van der Waal forces and their influence on solid state structure of the rare gases was investigated. Research was started in an effort to generalize the Bohm-Pines method to take into account the lattice. In order to get some insight into the correlation problem, a rather simple two electron problem was solved. Montroll and Ward applied field theoretical techniques to the interacting electron gas and were able to obtain formulas for the cancellation energy. The theory of polymer solutions, the Boltzmann equation, transport problems, dislocations, Lancaster-like equations, latent heat of the antiferromagnetic transition in chromium, and lattice sums were also investigated.

MDU.02:025

Maryland U. [Dept. of Physics] College Park.

ROLE OF BAND-BAND TRANSITIONS IN CHARACTERISTIC ENERGY LOSSES OF ELECTRONS PASSING THROUGH METAL FILMS (Abstract), by W. H. Lupton, R. A. Ferrell, and R. D. Myers. [1958] [1]p. [AF 18-(600)1015]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 191-192, May 1, 1958.

Various investigators of the characteristic energy losses in aluminum have found a small peak at approximately 7 ev in addition to the predominant peak at 15 ev due to plasmon production, and have speculated whether it is due to band-band transitions. According to Hubbard the energy loss probability is proportional to $|\text{Im}K^{-1}|$, where K is the complex dielectric constant, and hence $\text{Im}K$ would have a peak at 7 ev. But if $\text{Re}K \approx \omega_p^2/\omega^2$ and $|\text{Im}K^{-1}|$ has its maximum possible value, the calculated 7-ev energy loss probability is still only 0.7% of the probability of plasmon production. Furthermore, optical data do not exhibit such a peak at 7 ev. Hence we conclude that band-band transitions are not responsible for the 7-ev peak, which can instead be possibly ascribed to carbon contamination on the target foils. Calculations of the indirect effect of band-band excitation on the plasmon dispersion relation are in progress.

MDU.02:026

Maryland U. Dept. of Physics, College Park.

ON THE VIBRATIONS OF A GENERALIZED DIATOMIC LATTICE, by A. [A.] Maradudin and G. E. Weiss. [1959] [4]p. Incl. diagrs. refs. (AF 18(600)1015 and AF 18(600)1315)

Unclassified

MDU.03:025 - MDU.03:028

Published in Jour. Chem. Phys., v. 29: 631-634, Sept. 1958.

Some results are presented for regular diatomic chains whose unit cells contain more than two atoms. Using the transfer matrix method and certain theorems due to Hoffman and Mazur, the band structure is shown of the frequency spectra for chains whose unit cells contain three and four atoms. Finally the constant term is derived in the frequency spectrum of a disordered diatomic lattice. (Contractor's abstract)

MDU.03:025

Maryland U. Dept. of Physics, College Park.

ON THE LOW ENERGY CUTOFF OF THE COSMIC RADIATION, by S. F. Singer. July 25, 1956, rev. June 10, 1957 [9]p. incl. diagrs. refs. (Technical rept. no. 51) (AFOSR-TN-57-411) (AF 18(600)1038) AD 132490; AD 210188
Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Also published in Nuovo Cimento, Series X, Suppl., v. 8: 342-348, 1958.

The low energy cutoff knee in the primary cosmic radiation incident on the earth apparently depends on the solar cycle. It is unlikely that it is caused by a solar magnetic dipole field and it may not even be quite sharp. A model is developed to explain the absence of low energy nonrelativistic primaries based on diffusion deceleration coupled with ionization loss. Particles which have been decelerated by decreasing magnetic fields into the nonrelativistic range are likely to be trapped in a high field region and will disappear there by ionization loss. The position of the low energy cutoff and its change with time can be used as a tool to study the turbulence in interplanetary space. Various experimental approaches are indicated.

MDU.03:026

Maryland U. Dept. of Physics, College Park.

COSMIC RAY TIME VARIATIONS PRODUCED BY DECELERATION IN INTERPLANETARY SPACE, by S. F. Singer. July 25, 1956, rev. June 10, 1957 [13]p. incl. diagrs. refs. (Technical rept. no. 50) (AFOSR-TN-57-412) (AF 18(600)1038) AD 132491; AD 210187
Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Also published in Nuovo Cimento, Series X, Suppl., v. 8: 334-341, 1958.

It is suggested that Forbush cosmic ray decreases as well as the 27 day decreases of cosmic ray intensity are modulation effects produced primarily by the deceleration of cosmic rays in interplanetary space due to the expansion of turbulent gas clouds from the sun. The detailed mechanism is one of diffusive deceleration and can therefore be considered as an inverse to the Fermi acceleration mechanism. The cosmic ray intensity variation during the solar cycle is accounted for as the cumulative effect of this mechanism which operates in connection with emission of solar gas. In this way it is possible also to account for the decrease in Feb. 1946 which lasted 6 mo. Some experimental tests are suggested to discriminate between different theories for the origin of cosmic ray time variations.

MDU.03:027

Maryland U. Dept. of Physics, College Park.

ON THE ORIGIN OF THE CHARGE SPECTRUM OF THE PRIMARY COSMIC RADIATION, by S. F. Singer. June 1957 [10]p. incl. tables, refs. (Technical rept. no. 73) (AFOSR-TN-57-413) (AF 18(600)1038) AD 132492; AD 210190
Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Also published in Nuovo Cimento, Series X, Suppl., v. 8: 549-555, 1958.

The observed charge distribution of the primary cosmic radiation resembles the cosmic abundances of elements, but this resemblance is superficial. Severe discrepancies exist for Li, Be, and B, as well as for the ratio of heavy to medium nuclei. Much better agreement is obtained under the assumption that the original radiation consists mainly of heavy elements, principally Fe, and that nearly all of the lighter elements, including protons and alphas are produced by fragmentation. In the calculation new empirical data are used.

MDU.03:028

Maryland U. Dept. of Physics, College Park.

OBSERVATION OF COSMIC RAY DECREASES AT THE POLE, by S. F. Singer. June 1957 [12]p. incl. diagr. table, refs. (Technical rept. no. 74) (AFOSR-TN-57-414) (AF 18(600)1038) AD 132493; AD 210186
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 29-May 1, 1954.

Abstract published in Phys. Rev., v. 95: 647, July 15, 1954.

MDU.03:029 - MDU.03:032

Presented at Cosmic Ray Congress, Guanajuato (Mexico), Sept. 1955.

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Also published in Nuovo Cimento, Series X, Suppl., v. 8: 326-333, 1958.

Cosmic ray decreases of the Forbush type were observed in the immediate vicinity of the geomagnetic North pole during the summer of 1951. Their occurrence at the pole immediately rules out an equatorial ring current as their cause. A phenomenological picture is suggested for explaining some observed cases of cosmic ray storms without magnetic storms. The larger size of the polar decreases is explained on the basis of the focusing effect of the earth's magnetic field on primaries of different energies. The Forbush decreases are explained by a mechanism of diffusive deceleration which results from multiple reflection of the cosmic rays from receding centers of magnetic turbulence. This mechanism can be considered to be an inverse to the Fermi acceleration mechanism for cosmic rays.

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25, 1957.

Also published in Nuovo Cimento, Series X, v. 8: 539-548, May 16, 1958.

A lecture and a review have been presented on the dating of meteorites by means of chemical analysis of the isotopes produced by cosmic rays. The results of dating by means of H^3/He^3 ratio of 6 meteorites yield an age of 300 million years which compares favorably with calculations of the mean lifetime of meteorite-like bodies against capture by the inner planets. The mechanism of meteorite creation and the constancy of cosmic ray intensity have been considered.

MDU.03:031

Maryland U. Dept. of Physics, College Park.

A MODEL FOR SOLAR FLARE INCREASES OF COSMIC RAYS, by S. F. Singer. June 1957 [6]p. incl. diagrs. (Technical rept. no. 78) (AFOSR-TN-57-417) (AF 18-600)1038 AD 132496; AD 210189 Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Also published in Nuovo Cimento, Series X, Suppl., v. 8: 197-201, 1958. (Title varies)

A model is presented for the acceleration of cosmic ray flares in which only a small number of particles are given high energies and in which the geometry of the acceleration region determines the steepness of the energy spectrum. The statistical acceleration which occurs for the particles in the conducting gas in which turbulence is increasing is in part due to induction and in part to elastic collisions.

MDU.03:032

Maryland U. Dept. of Physics, College Park.

STUDIES OF A MINIMUM ORBITAL UNMANNED SATELLITE OF THE EARTH (MOUSE). PART III. RADIATION EQUILIBRIUM AND TEMPERATURE, by D. T. Goldman and S. F. Singer. [1957] [20]p. incl. diagrs. tables, refs. [AF 18(600)1038] Unclassified

Presented at Seventh Internat'l. Astronautical Congress, Rome (Italy), Sept. 1956.

Published in Astronautica Acta, v. 3: 110-129, 1957.

This paper deals with the problem of predicting the equilibrium temperature of an artificial earth satellite and of giving methods for designing and controlling its temperature under all types of conditions. The major

MDU.03:029

Maryland U. Dept. of Physics, College Park.

ENERGY SPECTRA OF PRIMARY COSMIC RAYS AND THE INTERPRETATION OF THEIR ORIGIN, by S. F. Singer. June 1957 [5]p. incl. table. (Technical rept. no. 77) (AFOSR-TN-57-415) (AF 18(600)1038) AD 132494; AD 210211 Unclassified

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Also published in Nuovo Cimento, Series X, Suppl., v. 8: 546-548, 1958.

A comprehensive analysis of experimental data on primary cosmic radiation reveals that the proton and alpha components of the primary radiation have different energy spectra. The best values for the constants k and c in the energy spectrum $N(>E) = kE^{-c}$ are 4000 and 1.15 respectively for the protons and 460 and 1.6 for the alpha particles. These values apply only to the particles which have energy in the latitude sensitive range.

MDU.03:030

Maryland U. Dept. of Physics, College Park.

COSMIC RAY EVIDENCE ON THE ORIGIN OF METEORITES, by S. F. Singer. Apr. 1957 [12]p. incl. tables, refs. (Technical rept. no. 66) (AFOSR-TN-57-416) (AF 18(600)1038) AD 132495 Unclassified

MDU.03:033 - MDU.03:036

heat sources are: (1) the sun; (2) sunlight reflected from the earth; and (3) long-wave radiation from the earth. Further, the additional production of heat by internal sources, such as nuclear power supplies, is considered. For a satellite traveling above the atmosphere the energy it receives is primarily transferred by radiation, infrared and visible. Therefore the equilibrium temperature of the satellite is determined by the properties of the satellite skin, i.e., its radiation characteristics (emissivity and albedo) in the visible and in the infrared regions of the spectrum. If we are dealing with a variable input of heat and are interested in the variation from the equilibrium temperature, then the thermal properties of the satellite body itself become of importance; the heat capacity of the satellite for example determines how rapidly it can follow the variation in heat input. We generally assume that the heat conductivity within the satellite is perfect so that all portions are at the same temperature, or at least that the skin is at an even temperature. Deviations from this ideal situation are considered separately. After we determine the sources of heat input in detail and after we discuss the small heat input effects (collision with the molecules, radicals, meteors, excited atoms, cosmic rays), we calculate the equilibrium temperature based on the equality of heat input and heat output, that is, a zero net flow of energy. The results for the equilibrium temperature are presented in the form of convenient nomograms to aid in preliminary design. (Contractor's abstract)

MDU.03:033

Maryland U. [Dept. of Physics] College Park.

ENERGY SPECTRA OF THE COMPONENTS OF THE PRIMARY COSMIC RADIATION (Abstract), by S. F. Singer. [1957] [1]p. [AF 18(600)1038] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 53, Jan 30, 1957.

A detailed analysis has been performed of balloon and rocket experiments including albedo and geomagnetic corrections. The analysis reveals that various primary components do not have the same velocity spectrum. In the relativistic portion of the latitude sensitive region expressions of the form aE^{-n} have been given for the particle flux density with energy greater than E . Values of the constants a and n have been found for protons, alpha particles, the group of elements C, N, O, and F, and for particles with Z greater than 10. An interpretation is given in terms of nuclear collisions and the resulting fragmentations of heavy primaries. However any clearcut experiments which demonstrate the absence of Li, Be, and B, or of H^2 , H^3 , and He^3 above the atmosphere would invalidate this interpretation. (Contractor's abstract, modified)

MDU.03:034

Maryland U. Dept. of Physics, College Park.

COSMIC RAY DECREASES DURING MAGNETIC STORMS (Abstract), by S. F. Singer. [1957] [1]p. [AF 18(600)-1038] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 192, Apr. 25, 1957.

Worldwide decreases of cosmic-ray intensity often occur during the main phase of magnetic storms. These Forbush-type events have been ascribed to the Störmer ring current (Chapman), or to a solar corpuscular beam (Alfven). Morrison, and more recently Parker, have postulated a highly turbulent magnetic field structure which partially screens the earth from cosmic rays by reflecting many particles without, however, changing their energy. In contradistinction, we consider here that the Forbush events result from a deceleration of cosmic rays; the energy decrease is produced in an inverse Fermi process which is set up as turbulent centers caused by a solar eruption expand outward and decay. Numerical estimates support this view. Crucial experimental tests will be discussed: (1) a possible shift in the position of the knee of the energy spectrum; (2) the spectrum of heavies compared to protons; and (3) the cosmic ray intensity at extremely large distances from the earth.

MDU.03:035

Maryland U. [Dept. of Physics] College Park.

A METHOD FOR CALCULATING IMPACT POINTS OF BALLISTIC ROCKETS, by S. F. Singer and R. C. Wentworth. [1957] [3]p. incl. diagrs. [AF 18(600)1038] Unclassified

Published in Jet Propulsion, v. 27: 407-409, Apr. 1957.

A simple method is developed for determining impact points of ballistic rockets on a rotating earth. Rapid computation is facilitated by graphs giving time of flight between two chosen points of the elliptic trajectory. The method is applied to calculate the dispersion of an extreme high altitude unguided rocket. (Contractor's abstract)

MDU.03:036

Maryland U. Dept. of Physics, College Park.

RELATIVITY AND SPACE TRAVEL, by S. F. Singer. Jan. 3, 1957, 2p. (Technical rept. no. 61) [AF 18(600)-1038] Unclassified

MDU.03:037 - MDU.03:040

Published in Nature, v. 179: 977, May 11, 1957.

An argument is presented for the non-symmetrical nature of observers in orbiting earth satellites and observers stationary on the earth. An appeal is made for an orbiting atomic clock experiment to check the time dilation of such motion and gravitational red shift due to the earth.

90 per cent of the contribution to the detector response is made. The sensitivity of the method to changes in the ozone concentration at various altitudes is also demonstrated. (Contractor's abstract)

MDU.03:039

Maryland U. Dept. of Physics, College Park.

PROJECT FAR SIDE: MAN'S FIRST STRIDE INTO SPACE USES OFF-THE-SHELF HARDWARE, by S. F. Singer. [1957] [9]p. incl. illus. diagrs. [AF 18(600)-1038] Unclassified

Published in Missiles and Rockets, v. 2: 120-128, Oct. 1957.

A new dimension has been added to high altitude research: Far Side, which will explore space out to one earth radius (4000 miles) and possibly higher. Conceived by scientists of the Air Force Office of Scientific Research and developed by Aeronutronic Systems, Inc., the Far Side vehicle is a low-cost solution for reaching the highest altitudes yet attained by man. It is a multi-stage rocket launched at high altitude to overcome the atmospheric drag; specifically it is a four-stage combination of ten solid rocket motors lifted by a Skyhook balloon to an altitude of over 100,000 ft. The 1900-lb vehicle carries only a three-and-a-half-lb payload. In this paper on Project Far Side, the following topics are discussed: high altitude vehicles, the team behind Far Side, technical aspects, propulsion, dynamics and trajectories, scientific applications, the outer ionosphere, earth's magnetic field, cosmic rays, auroral particles, interplanetary dust, significance of experiments, long time exposures and recovery.

MDU.03:037

Maryland U. Dept. of Physics, College Park.

BF₃ NEUTRON SPARK COUNTER, by M. J. Swetnick and N. G. Anton. [1957] [1]p. incl. diagrs. table. [AF 18(600)1038] Unclassified

Published in Nucleonics, v. 15: 93, June 1957.

With a Rosenblum spark counter operated in a BF₃ atmosphere it was possible to achieve a slow-neutron detection efficiency of 0.6%. Yet the system proved to be completely insensitive to Co⁶⁰ radiation at 500r/hr. External circuitry required is limited to a high-voltage supply and a scaler. It is possible, if so desired, to convert the slow-neutron-sensitive spark counter into a fast-neutron-sensitive spark counter by paraffin encasement of the detector and cadmium shielding of exposed surfaces.

MDU.03:038

Maryland U. Dept. of Physics, College Park.

A METHOD FOR THE DETERMINATION OF THE VERTICAL OZONE DISTRIBUTION FROM A SATELLITE, by S. F. Singer and R. C. Wentworth. [1957] [10]p. incl. diagrs. refs. (AF 18(600)1038) Unclassified

Published in Jour. Geophys. Research, v. 62: 299-308, June 1957.

Because of its long lifetime below 45 km, ozone can deviate markedly from the concentration given by photochemical equilibrium considerations. Hence the ozone concentration can be used as an indicator of the motion of air masses, particularly in the stratosphere. The meteorological implications can be fully realized only by synoptic measurements, for which an artificial earth satellite is ideally suited. The method described employs the optical absorption properties of ozone in the ultraviolet region around 2900A. A detector looking down towards the earth will receive solar ultraviolet scattered by the atmosphere which has been attenuated both by scattering out and by ozone absorption. Calculations are presented to illustrate the effective depth in the atmosphere to which the detector "sees" the effective depth being defined as the point above which

MDU.03:040

Maryland U. Dept. of Physics, College Park.

COSMIC-RAY INCREASES PRODUCED BY SMALL SOLAR FLARES, by J. J. Corrigan, S. F. Singer, and M. J. Swetnick. July 1958, 4p. incl. diagr. (AFOSR-TN-58-949) (AF 18(600)1038) AD 205342 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 71, Jan. 29, 1958.

Also published in Phys. Rev. Letters, v. 1: 104-105, Aug. 1, 1958.

Two short duration (3 min) low energy cosmic ray increases have been observed at 55° geomagnetic latitude and at 25,000 ft and have been correlated with the presence of a solar flare, radio noise storm and shortwave

MDU.03:041 - MDU.03:045

fadeout. The reported increases had a humped profile rather than a sharp rise and exponential decay as ordinarily observed.

MDU.03:041

Maryland U. Dept. of Physics, College Park.

SCIENTIFIC USES OF CISLUNAR VEHICLES, by S. F. Singer. [1958] [7]p. incl. diagr. (AFOSR-TN-58-950) (AF 18(600)1038) AD 205343 Unclassified

Presented at Second Annual AFOSR Astronautic Symposium, Denver, Colo., Apr. 1958.

Also published in Vistas in Astronautics, v. 2: 32-38, 1959.

Scientific measurements which can be carried out by satellite vehicles in the cislunar region between the Earth and the Moon are discussed. Emphasis is placed on such problems as the space distribution and intensity of cosmic rays and auroral particles; gravitational field of the earth and moon including better values of lunar mass and relativistic effects; and the existence of equatorial ring current near the earth which produces sea-level magnetic field decreases. The Moon's magnetic field and measurements of the lunar atmosphere and lunar tidal bulge are discussed. (Contractor's abstract, modified)

MDU.03:042

Maryland U. Dept. of Physics, College Park.

TRAPPED ALBEDO THEORY OF THE RADIATION BELT, by S. F. Singer. [1958] [3]p. (AFOSR-TN-58-951) (AF 18(600)1038) AD 205344 Unclassified

Also published in Phys. Rev. Letters, v. 1: 181-183, Sept. 1, 1958.

A theory is described for the radiation belt of the earth which gives the energy spectrum, angular distribution, and intensity of the radiation as a function of radial distance up to a distance of approximately 1 earth radius. Results are not compatible with data reported by Explorer satellites I and II but are compatible with preliminary data from Explorer IV.

MDU.03:043

Maryland U. Dept. of Physics, College Park.

ARTIFICIAL MODIFICATION OF THE EARTH'S RADIATION BELT, by S. F. Singer. [1958] [20]p. incl. diagr. table, refs. (AFOSR-TN-58-952) (AF 18(600)1036) AD 205345 Unclassified

Presented at meeting of the Amer. Astronaut. Soc., Washington, D. C., Dec. 27-31, 1958.

Published in Advances in Astronaut. Sciences, v. 4: 335-354, 1958.

The trapping properties of the earth's magnetic field have been investigated. It appears that high-energy protons and electrons can "live" for long periods of time, so that a small injection rate can build up large intensities. Natural injection mechanisms exist in the form of solar corpuscular radiation and in the form of cosmic ray albedo, leading to a "soft" and a "hard" radiation belt around the earth. A discussion is given of a proposal for artificial injection of electrons from a rocket-borne accelerator, as well as some of the consequences and applications of this technique. (Contractor's abstract)

MDU.03:044

Maryland U. Dept. of Physics, College Park.

"RADIATION BELT" AND TRAPPED COSMIC-RAY ALBEDO, by S. F. Singer. [1958] [3]p. incl. diagr. (AFOSR-TN-58-953) (AF 18(600)1038) AD 205346 Unclassified

Also published in Phys. Rev. Letters, v. 1: 171-173, Sept. 1, 1958.

In order to explain the radiation observed by Explorer satellites, calculations have been performed on the trapping of cosmic-ray albedo particles. Expressions are given for the pitch-angle distribution at the equator, rate of leakage of particles and for the mean lifetime of the radiation particles.

MDU.03:045

Maryland U. [Dept. of Physics] College Park.

EFFECTS OF INTERPLANETARY DUST AND RADIATION ENVIRONMENT ON SPACE VEHICLES, by S. F. Singer. [1958] [42]p. incl. diagrs. tables, refs. (AFOSR-TN-58-1018) (AF 18(600)1038) AD 162283 Unclassified

Also published in Proc. Second Internat'l. Symposium on the Physics and Medicine of the Atmosphere and Space, San Antonio, Tex. (Nov. 10-12, 1958), New York, Wiley and Sons, 1960, p. 60-90.

Material particles from slowly moving interplanetary dust to fast cosmic rays will impinge on vehicles outside of the protection of the earth's atmosphere. A discussion is given of the effects which are likely to influence the operation of spacecraft and their occupants. The first part of the paper deals with meteoric erosion (including methods of measurement and simulation) and sputtering produced by the impact of solar gas in interplanetary

MDU.03:046-048; MDU.04:002

space. Next, radiation effects produced by low energy cosmic rays and especially by the earth's radiation belt are discussed. Particular attention is given to the design of a proper shield against low energy protons which is important when their intensities are very high. On the other hand, it may be possible to reduce the intensities of the radiation belt protons by "space sweeping". (Contractor's abstract)

MDU.03:046

Maryland U. [Dept. of Physics] College Park.

NEW ACCELERATION MECHANISM FOR AURORAL PARTICLES (Abstract), by S. F. Singer. [1958] [1]p. [AF 18(600)1038] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 40, Jan. 29, 1958.

Acceleration of solar protons (mean energy ~20 kev) to auroral energies (~1 mev as deduced from atmospheric penetration) is a longstanding problem. The acceleration mechanism operates near the earth on "trapped" protons, these oscillate back and forth along magnetic force lines while drifting azimuthally to produce the magnetic storm ring current. Two basic processes are described. (1) "Fermi collisions" with hydromagnetic waves which are excited by solar protons and guided by lines of force; their existence also explains observations of geomagnetic micropulsations. (2) Induction acceleration via the earth's field by bunched protons; this also explains observations of vlf radio emissions. The two processes in "push-pull" keep the proton's pitch angle from becoming too small too soon. Thus the proton gains much energy before it breaks out of the trap and into the atmosphere. This statistical acceleration process leads to an energy spectrum as suggested observationally. The push-pull scheme may also be important for galactic cosmic ray acceleration.

MDU.03:047

Maryland U. Dept. of Physics, College Park.

A NEW THEORY OF THE AURORA (Abstract), by S. F. Singer. [1958] [1]p. (AF 18(600)1038) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., Apr. 23-26, 1958.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-6: 312, July 1958.

A long-standing problem is to explain the energy of auroral protons. The author shows here that solar

protons trapped in the earth's magnetic field can be accelerated up to auroral energies. The mechanism does not use electric fields (e.g., Martyn or Alfvén). Instead some of the protons are accelerated by magneto-hydrodynamic waves which are in turn produced by the bulk of the solar protons. In this acceleration process the earth's magnetic field acts as the energy transfer agent. There is additional empirical evidence supporting the proposed mechanism, namely geomagnetic micropulsations, the VHF emissions from the upper atmosphere, and the evidence that the auroral protons have a distribution of energies.

MDU.03:048

Maryland U. [Dept. of Physics] College Park.

A METHOD FOR CALCULATING IMPACT POINTS OF BALLISTIC ROCKETS: CONVENIENT REPRESENTATIONS, by S. F. Singer and R. C. Wentworth. [1958] [4]p. Incl. diagrs. [AF 18(600)1038] Unclassified

Published in Jet Propulsion, v. 28: 684-687, Oct. 1958.

A method for determining impact points of ballistic rockets on a rotating Earth has been developed by Singer and Wentworth (item no. MDU.03:035). In this note, a dimensionless representation is given which puts the results of the previous report in a more convenient form and also amends the previous report to include non-equatorial launchings.

MDU.04:002

Maryland U. [Dept. of Physics] College Park.

THE DETECTION AND IDENTIFICATION BY ELECTRON SPIN RESONANCE TECHNIQUES OF TRAPPED FREE RADICALS (Abstract), by R. S. Anderson. [1957] [2]p. (AF 18(600)1582) Unclassified

Published in Program for Symposium of The Formation and Stabilization of Free Radicals, Nat'l. Bur. Standards, Washington, D. C. (Sept. 18-20, 1957), Washington, Nat'l. Bur. Standards, 1957, p. M1-M2.

Free radicals have been produced by ultraviolet irradiation of materials maintained at liquid nitrogen temperature. The irradiated material is examined for free radicals by subsequent observation, at liquid nitrogen temperature, in an electron spin resonance spectrometer. Approximately 125 compounds, mostly organic, have been examined by this method. Of this number about 100 have exhibited electron spin resonances indicative of the presence of free radicals trapped at the low temperatures. Identification of the resulting radicals, where possible, has been based upon the hyperfine structure exhibited by the resonances, both through the number of hyperfine components and their relative intensities. Observations have been made at both 3 and 1.2 cm

MDU.04:003 - MDU.04:005

wavelengths and it is significant that all resonances have been observed at a g-factor of 2, in spite of search over a wide range of magnetic fields. The following classes of compounds have been examined: saturated and unsaturated hydrocarbons, alcohols, acids and their anhydrides, aldehydes, ketones, esters, ethers, alkyl and aryl halides, and nitro-compounds. In general, no resonances have been observed in materials having melting points below 137°K, that is, less than 60° above the temperature of the irradiated material. While free radicals may generally be stabilized for long periods at low temperatures, some irradiated substances were observed to have different resonances after storage for a few days. Where two different resonance patterns appear superimposed, one, presumably the more reactive, may disappear. In other cases, the original resonance may decay and be replaced by a totally different resonance, indicating secondary reactions.

MDU.04:003

Maryland U. [Dept. of Physics] College Park.

ELECTRON SPIN RESONANCE LINE SHAPES FOR SOLIDS HAVING NONISOTROPIC g FACTORS (Abstract), by R. P. Kohin and C. P. Poole, Jr. [1958] [1]p. [AF 18(600)1582] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 8-9, Jan. 29, 1958.

The line shape for a paramagnetic substance having three unequal g tensor components $g_1 > g_2 > g_3$ and a spin of $\frac{1}{2}$ is derived assuming that the molecules have a random distribution of orientations. If the component line shape for a particular orientation is assumed to have zero width, the line shape, normalized to unit area, is

$$I(g) = \frac{2gK(b/a)/\pi a}{0} \quad g_3 \leq g \leq g_2 \\ \frac{2gK(a/b)/\pi b}{\text{otherwise,}} \quad g_2 \leq g \leq g_1$$

where

$$a = [(\frac{1}{2}g_2^2 - \frac{1}{2}g_3^2)(g_1 - g_2)^2]^{\frac{1}{2}} \\ b = [(\frac{1}{2}g_1^2 - \frac{1}{2}g_2^2)(g_2 - g_3)^2]^{\frac{1}{2}}$$

and K(k) is a complete elliptic integral of the first kind. This line shape is characterized by an infinite peak at $g = g_2$ and shoulders at $g = g_1$ and g_3 . Integrations performed over nonzero component line widths are discussed.

MDU.04:004

Maryland U. Dept. of Physics, College Park.

ELECTRON SPIN RESONANCE OF ULTRAVIOLET IRRADIATED COMPOUNDS (Abstract), by C. P. Poole, Jr. and R. S. Anderson. [1958] [1]p. [AF 18(600)1582] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 8, Jan. 29, 1958.

The 9000 mc electron spin resonance spectra of over 100 ultraviolet irradiated organic compounds maintained at 77°K have been recorded at a g factor of two. The mechanism of radical production entails the absorption of the photon by a pi electron and the subsequent rupture of a nearby bond. Unsaturated hydrocarbons show well-resolved, symmetric, evenly spaced hyperfine structure of three to six lines. Aldehydes are characterized by a strong singlet attributed to the formyl radical on which there is superposed weaker time decaying multicomponent structure attributed to alkyl radicals. Nitrogen-containing compounds exhibit triplet structure resulting from the nuclear spin of nitrogen. Other classes of compounds will be discussed, including ketones, esters, acids, anhydrides, and halides. In general the resonances obtained are characteristic of the class of compound irradiated, and in many cases the radicals may be identified by the spacing and intensity ratios of the hyperfine structure components. Line widths and component separations are about two milliwobers per square meter. Line widths calculated from dipole-dipole interaction with surrounding protons agree with the observed widths. While most radicals are stable for weeks at 77°K, some change or decay with time indicating secondary reactions.

MDU.04:005

Maryland U. [Dept. of Physics] College Park.

ELECTRON SPIN RESONANCE OF FREE RADICALS IN ULTRAVIOLET IRRADIATED HYDROCARBONS, ALDEHYDES, AND KETONES (Abstract), by C. P. Poole, Jr. and R. S. Anderson. [1958] [1]p. [AF 18(600)1582] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 179, May 1, 1958.

Unsaturated hydrocarbons, aldehydes, and ketones, maintained at 77°K, have been exposed for approximately 6 hr to the ultraviolet radiation from a high-pressure mercury arc. Electron spin resonance spectra, observed at a g factor of 2 with a 9000-mc spectrometer, are

MDU.16:001 - MDU.16:004

characteristic of the substances irradiated. Interpretation of specific hydrocarbon cases will be used to show that the characteristic hyperfine structure may be attributed both to hyperconjugation and the $\sigma - \pi$ interaction between the unpaired electron and neighboring hydrogen atoms in the radical. Aldehydes and ketones produce singlets attributed to formyl (CHO) and alkanoyl (RCO) radicals. The strong electronegativity of the oxygen on the carbonyl group (CO) suppresses the contact hyperfine interaction between the free electron and neighboring hydrogen atoms. Alkyl radicals formed simultaneously with the alkanoyl radicals appear similar to the photolysis products of unsaturated hydrocarbons.

MDU.16:001

Maryland U. [Dept. of Physics] College Park.

CAUSALITY AND THE DISPERSION RELATION: LOGICAL FOUNDATIONS, by J. S. Toll. [1956] [11]p. incl. diagr. refs. [Technical rept. no. 27] [AF 49(638)-24] Unclassified

Published in Phys. Rev., v. 104: 1760-1770, Dec. 15, 1956.

"Strict causality" is the assumption that no signal whatsoever can be transmitted over a space-like interval in space-time, or that no signal can travel faster than the velocity of light in vacuo. In this paper a rigorous proof is given of the logical equivalence of strict causality ("no output before the input") and the validity of a dispersion relation, e.g., the relation expressing the real part of a generalized scattering amplitude as an integral involving the imaginary part. This proof applies to a general linear system with a time-dependent connection between the output and a freely variable input and has the advantage over previous work that no tacit assumptions are made about the analytic behavior or single-valuedness of the amplitude, but, on the contrary, strict causality is shown to imply that the generalized scattering amplitude is analytic in the upper half of the complex frequency plane. The dispersion relations are given first as a relation between the real and imaginary parts of the generalized scattering amplitude and then in terms of the complex phase shift. (Contractor's abstract)

MDU.16:002

Maryland U. [Dept. of Physics] College Park.

DISPERSION RELATIONS FOR NON-RELATIVISTIC PARTICLES (Abstract), by D. Y. Wong. Jan. 1957, 9p. (Technical rept. no. 62) (AFOSR-TN-57-35) (AF 49(638)24) AD 115073 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 177, Apr. 25, 1957.

Also published in Phys. Rev., v. 107: 302-306, July 1, 1957.

If the wave function of a non-relativistic particle satisfies the Schrödinger equation with a velocity independent potential, then its scattering amplitudes (and the S-matrix in general) satisfy the same dispersion formulas as those derived for the scattering of light. In the present derivation, the validity of a perturbation expansion and certain integrability of the potential are assumed, and the requirement of the outgoing wave Green's function replaces the condition of strict causality for the scattering of light. The scattering amplitude for fixed momentum transfer is also shown to satisfy the dispersion relations. If the potential possesses bound states, then all the dispersion formulas are modified to include residue terms corresponding to singularities on the positive imaginary axis of the momentum plane. The necessity of these modifications are related to the divergence of the perturbation series for small wave numbers. Essential singularities of the S-matrix due to exponential-type potentials give no additional contribution to the dispersion formulas. (Contractor's abstract)

MDU.16:003

Maryland U. Dept. of Physics, College Park.

REMARKS ON THE IMPLICATION OF "CAUSALITY CONDITION IN NON-INTERACTION REGION" AND THE UNITARITY OF THE S-MATRIX, by D. Y. Wong. July 1957, 6p. (Technical rept. no. 82) (AFOSR-TN-57-351) (AF 49(638)24) AD 132424 Unclassified

For the scattering of light by a spherically symmetric scatterer of finite range, the requirement of causality in the non-interaction region plus the unitarity of the S-matrix is shown to be sufficient for the determination of the imaginary part of the S-matrix element from its real part. This holds for each matrix element with a given angular momentum quantum number ℓ . Ambiguity occurs only for the case when the S-matrix element is a pure exponential function of the frequency. (Contractor's abstract)

MDU.16:004

Maryland U. Dept. of Physics, College Park.

APPLICATION OF DISPERSION RELATION AND UNITARITY CONDITION TO NON-COHERENT FORWARD SCATTERING OF LIGHT BY LIGHT, by D. Y. Wong. July 1957, 9p. (Technical rept. no. 81) (AFOSR-TN-57-351A) (AF 49(638)24) AD 132487 Unclassified

By the unitarity condition, the imaginary part of the matrix element for the non-coherent forward scattering

MDU.16:005 - MDU.16:008

of light by light is obtained from the pair-production amplitude. The real part of the matrix element is then determined from the imaginary part by the dispersion relation. The result agrees with the well-known field theoretic calculation (R. Karplus and M. Neuman, Phys. Rev., v. 83: 776, 1951).

MDU.16:005

Maryland U. Dept. of Physics, College Park.

A POSSIBLE PROOF OF DISPERSION RELATIONS, by H. J. Bremermann, R. Oehme, and J. G. Taylor. July 1957, 15p. (Technical rept. no. 84) (AFOSR-TN-57-467) (In cooperation with Inst. for Advanced Study, Princeton, N. J.) (AF 49(638)24) AD 136458

Unclassified

Presented at Internat'l. Conf. on Mathematical Problems of Quantum Field Theory, Lille (France), June 1957.

By the theory of functions of more than one complex variable, the dispersion formulas of quantum field theory can be proved with essentially only Wightman's axioms and the known properties of the spectrum. Certain assumptions are made on the Fourier transforms, and a rigorous proof of the basic theorem is described briefly. For simplicity, the elastic scattering of neutral scalar bosons of equal mass is considered. A question is posed concerning the development of a method for determining the envelope of holomorphy of a domain which is invariant under the homogeneous Lorentz group, or invariant under other similar transformation groups. A special method of solution for the envelope is used which introduces certain restrictions. For pion-nucleon scattering the semi-tube method of proof presented for the theorem is satisfactory; however, it is not sufficient for the nucleon-nucleon, K-meson-nucleon and photon-nucleon scattering processes.

MDU.16:006

Maryland U. Dept. of Physics, College Park.

UNIQUENESS OF SOLUTIONS TO DISPERSION RELATIONS AND AN ITERATIVE SCHEME, by D. Y. Wong. July 1957, 10p. incl. table. (Technical rept. no. 85) (AFOSR-TN-57-468) (AF 49(638)24) AD 136459

Unclassified

For a given set of low energy limits of the S-matrix, the solution of the dispersion relation for the scattering of light is shown to be non-unique even if one fixes all but the s-wave phase shift. Here the unitarity condition is also implied. It is known (D. Y. Wong and J. S. Toll, Ann. Phys., v. 1: 91, 1957) that if one further assumes the convergence of the usual perturbation method, then the low energy limits do determine the physical solution uniquely. An alternative iterative scheme is suggested

without recourse to the expansion in powers of a coupling parameter. The procedure is illustrated by the example of the scattering by a hard sphere.

MDU.16:007

Maryland U. Dept. of Physics, College Park.

CAUSALITY AND THE DISPERSION RELATION: S-MATRIX FOR KLEIN-GORDON AND DIRAC FIELD, by J. M. Knight and J. S. Toll. Aug. 1957, 47p. incl. diagr. (Technical rept. no. 87) (AFOSR-TN-57-552) (AF 49(638)24) AD 136536

Unclassified

Also published in Ann. Phys., v. 3: 49-66, Jan. 1958.

The causality condition is used to derive analytic properties and dispersion relations for the S-matrix $S(\omega)$ for the case of unquantized Klein-Gordon and Dirac fields interacting with a fixed spherically symmetric scatterer of finite radius. It is shown that $S(\omega)e^{2i\omega a}$ as a function of the energy ω is analytic and bounded in the upper half ω -plane, where a is the radius of the scatterer. An infinite sequence of scattering amplitudes which satisfy a dispersion relation are given in terms of the elements of the S-matrix. The real part of the S-matrix is expressed in terms of its imaginary part and a set of constants by means of the dispersion relation. (Contractor's abstract)

MDU.16:008

Maryland U. [Dept. of Physics] College Park.

DISPERSION RELATIONS FOR THE S-MATRIX (Abstract), by J. S. Toll, D. Y. Wong, and J. M. Knight. [1957] [1]p. [AF 49(638)24]

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 13, Jan. 30, 1957.

Dispersion relations for the S-matrix for fixed spherically symmetric scatterers of finite extent are derived to illustrate restrictions implied by strict causality on scattering through nonzero angles. The forward scattering of appropriate combinations of point sources and plane waves yields an infinite sequence of causal amplitudes which satisfy conventional dispersion relations. Inverting the relation for these causal amplitudes in terms of the S-matrix, one obtains dispersion formulas which give $\lim_{m \rightarrow \infty} S_m(\omega)$ for each m , in terms of combinations of the $\text{Re} S_\ell(\omega)$'s plus low energy limits of

$[S_\ell(\omega)/\omega^{2\ell+1}]$ for all $\ell \geq m$. Hence the real part of the scattering amplitude is determined by its imaginary

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part plus low-energy limits of $[S_\ell(\omega)/\omega^{2\ell+1}]$. If a perturbation expansion method is valid, then low-energy limits determine all phase shifts, or the s wave determines all other phase shifts. The massless scalar field, Maxwell field, Klein-Gordon field, and Dirac field are treated. The equivalent formulation of dispersion relations for the S-matrix in terms of the vanishing of commutators is derived and is being applied to Delbrueck scattering.

MDU.16:009

Maryland U. [Dept. of Physics] College Park.

BOUND STATE CONTRIBUTION TO DISPERSION RELATIONS FOR THE SCATTERING MATRIX (Abstract), by J. M. Knight and J. S. Toll. [1957] [1]p. [AF 49(638)-24] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 177, Apr. 25, 1957.

Previous derivations by Toll, Wong, and Knight of the dispersion relations for the scattering matrix for a relativistic particle scattered by a fixed, finite, spherically symmetric scatterer can be modified to include interactions which permit bound states. A typical bound state of energy $\hbar\omega_B$ introduces a simple pole at $\omega = \omega_B$ in the corresponding element of the scattering matrix. For the ground state, this pole lies on the real frequency axis; to eliminate this singularity, a factor $(\omega - \omega_B)$ is introduced, which adds one arbitrary constant to the resulting dispersion relations. Metastable states correspond to singularities in the lower half of the complex frequency plane, which cause no alteration in the derivation or final form of the dispersion relations. Examples and applications are discussed.

MDU.16:010

Maryland U. Dept. of Physics, College Park.

CAUSALITY AND THE DISPERSION RELATION: S-MATRIX FOR THE MAXWELL FIELD, by D. Y. Wong and J. S. Toll. [1957] [21]p. incl. refs. [AF 49(638)24] Unclassified

Published in Ann. Phys., v. 1: 91-111, Apr. 1957.

The scattering of a classical Maxwell field by a fixed spherically symmetric scatterer of finite range is considered. This problem is easily related to the scattering of a scalar field which is considered first. The condition of strict causality is imposed on the forward scattering of a sequence of primary scalar wave packets

$\{\phi_p^{(n)}\}$, $n = 0, 1, 2, \dots$, in which the n th primary wave contains only partial waves for $\ell \geq n$. This implies that the dispersion relation is satisfied by each member of an infinite set of causal amplitudes which are expressed as combinations of the elements of the S-matrix $\{S_\ell(\omega)\}$. Inverting the relation for the causal amplitudes in terms of the S-matrix, one obtains a set of dispersion formulas which give $\text{Im}S_m(\omega)$, for each m , in terms of combinations of the $\text{Re}S_\ell(\omega)$'s plus the low energy limits of $[S_\ell(\omega)/\omega^{2\ell+1}]$ for all $\ell \geq m$. Hence the real part of the scattering amplitude, for all angles and frequencies, is determined by the knowledge of its imaginary part plus the low energy limits of $[S_\ell(\omega)/\omega^{2\ell+1}]$. Corresponding formulas exist for $\text{Re}S_m(\omega)$ and the imaginary part of the scattering amplitude. If a perturbation expansion method is valid, then the restriction is much stronger, namely, low energy limits determine all phase shifts, or, equivalently, the s-wave phase shift determines the phase shift for all higher angular momenta. The scattering of the Maxwell field is described by three matrices, corresponding to the two transverse modes and one longitudinal mode; each of these matrices is shown to satisfy the same set of dispersion relations as that for scalar waves, except for the omission of the s-wave equation in the case of transverse modes. The equivalent formulation of the derivation of the dispersion relations for the S-matrix in terms of the vanishing of commutators is given in an Appendix for the case of the scattering of scalar wave by a static potential. (Contractor's abstract)

MDU.16:011

Maryland U. Dept. of Physics, College Park.

ON THE RADIATIVE CORRECTIONS TO THE SCATTERING OF MESONS IN AN EXTERNAL ELECTROMAGNETIC FIELD, by A. K. Bhatia and J. Sucher. May 1958, 24p. incl. diagrs. (Technical rept. no. 103) (AFOSR-TN-58-446) (AF 49(638)24) AD 158251 Unclassified

Also published in Prog. Theoret. Phys. (Japan), v. 20: 397-398, Sept. 1958.

The second order radiative corrections to the scattering of a spin-zero particle in an external electromagnetic field have been calculated with the aid of the Klein-Gordon formalism. After rectification of an error in the earlier work of Kinoshita and Nambu (Prog. Theoret. Phys. Kyoto V: 473, 749, 1950), who used the Duffin-Kemmer formalism, the present result is in agreement with the corrected result of these authors. (Contractor's abstract)

MDU.16:012 - MDU.16:016

MDU.16:012

Maryland U. Dept. of Physics, College Park.

DISPERSION RELATIONS AND SCHWARTZ'S DISTRIBUTIONS, by J. G. Taylor. [1958] 12p. incl. refs. (Technical rept. no. 109) (AFOSR-TN-58-830) (AF 49-838)24 AD 162180 Unclassified

Also published in Ann. Phys., v. 5: 391-398, Dec. 1958.

The equivalence between strict causality and dispersion relation for a system with an output which is a linear time-independent of the input is shown to hold under the very general condition that the time-delay distribution $A(t)$ is a tempered distribution in the sense of Schwartz. This result is necessary for a rg distribution of the dispersion relation in QFT and in part is used to prove the theory of boundedness in the edge of the wedge which has been used in that proof and also in dispersion of causality in QFT.

MDU.16:013

Maryland U. Dept. of Physics, College Park.

NOTE ON THE FORMULATION OF THE CAUSALITY REQUIREMENT, by J. G. Taylor and J. S. Toll. [1958] 13p. incl. diagr. (Technical rept. no. 110) (AFOSR-TN-58-631) (AF 49(538)24) AD 162161 Unclassified

Segal's recent formulation of the causality requirement (Phys. Rev., v. 109: 2191, 1958) is considered. This formulation is shown to differ in important respects from the usual requirement of "no output before input" and certain difficulties of physical interpretation are discussed. Segal's formulation is shown to be more restrictive than the usual strict causality and to exclude bound states and certain types of resonances that occur in theories of physical interest. The discussion of the Klein-Gordon wave in terms of the characteristic momentum variable is analyzed further and the way in which Segal's formulation extends the domain of analyticity is described. (Contractor's abstract)

MDU.16:014

Maryland U. Dept. of Physics, College Park.

THE CONSTRUCTION OF THE DIRAC EQUATION CENTRAL POTENTIAL FROM PHASE SHIFTS AND BOUND STATES, by F. Prata. [1958] 112p. incl. diagr. refs. (Technical rept. no. 112) (AFOSR-TN-58-832) (AF 49(638)24) AD 162162 Unclassified

Also published in Phys. Rev., v. 113: 363-370, Jan. 1, 1959.

The problem of the connection between phase shifts, bound state energies and the potential is studied for a

Dirac particle in a spherically symmetric potential. An explicit method is developed for the construction of the potential from the scattering and bound state data for a single angular momentum and parity. The technique used in this relativistic problem is an extension, appropriately generalized to matrices of the methods used by R. Jost and W. Kohn (Phys. Rev., v. 87: 977, 1952 and v. 88: 382, 1952) for the non-relativistic case.

MDU.16:015

Maryland U. Dept. of Physics, College Park.

THE FORMATION OF DISCONTINUITIES IN NON-LINEAR ELECTRODYNAMICS, by M. Lutzky. [1958] [30]p. incl. diagr. table. (Technical rept. no. 111) (AFOSR-TN-58-633) (AF 49(838)24) AD 162163; PB 136400 Unclassified

Also published in Phys. Rev., v. 113: 1649-1652, Mar. 15, 1959.

Discontinuities can develop in the propagation of initially smooth waves governed by a classical non-linear theory of electrodynamics. The type of theory considered includes as a special case that of Heisenberg and Euler, up to second order in the invariants of the field. This theory describes the modifications that must be made in the Maxwell equations to include the classical limit of the non-linear vacuum effects of quantum electrodynamics. A particular solution of the equations is constructed by the method of characteristics. This solution illustrates how, with the appropriate well-behaved initial conditions, the characteristics can be made to intersect at later times, thus forming discontinuities. It is pointed out that the classical approximation fails when the gradient of the field strength becomes large, so that no definite conclusion can be drawn as to the actual physical creation of singularities. A more refined theory must be used to decide what occurs in the singular region. (Contractor's abstract)

MDU.18:016

Maryland U. Dept. of Physics, College Park.

LECTURES ON DISPERSION RELATIONS ON QUANTUM FIELD THEORY AND RELATED TOPICS, by J. G. Taylor. [1958] 1v. incl. diagr. refs. (Technical rept. no. 115, vol. 1) (AFOSR-TN-58-816a) (AF 49(638)24) AD 202639 Unclassified

The lectures on the dispersion relations in quantum field theory given at the University of Maryland in the summer of 1958 have been reproduced in three volumes. Volume I contains the following topics: (1) the analytic properties of the S-matrix elements and dispersion relations for the scattering of (a) light by spherically symmetric scatterer and (b) non-relativistic Schrödinger particles by a central potential; (2) the general

MDU. 16:017-019; MDU. 17:001, 002

requirements for any quantum field theory and the expressions for the S-matrix elements in such a theory; (3) proof of the dispersion relations by formulation of the problem in terms of the absorptive part and solution of the problem by the edge of the wedge theorem and the Jost-Lehmann-Dyson representation; and (4) the resulting limitations on the dispersion relations such as limitations on momentum transfer or as mass restrictions for processes of experimental interest.

MDU.16:017

Maryland U. Dept. of Physics, College Park.

LECTURES ON DISPERSION RELATIONS IN QUANTUM FIELD THEORY AND RELATED TOPICS, by J. G. Taylor. [1958] 1v. incl. diagrs. (Technical rept. no. 115, vol. 2) (AFOSR-TN-58-816b) (AF 49(638)24) AD 202640 Unclassified

Volume II contains the following topics: (1) extension of general requirements for any quantum field theory, proof of dispersion relations, and the resulting limitations on the dispersion relations to include bound states as components of in or out states; (2) restrictions to the validity of dispersion relations arising in perturbation theory; (3) application of dispersion relations to (a) π -N and N-N scattering and to photo-pion production, (b) determination of the parity of the K-meson, (c) electromagnetic structure of the nucleon, and (d) weak interactions; and (4) analyticity of scattering amplitudes in momentum transfer including the problem of proof and the determination of the π -N coupling constant.

MDU.16:018

Maryland U. Dept. of Physics, College Park.

LECTURES ON DISPERSION RELATIONS IN QUANTUM FIELD THEORY AND RELATED TOPICS, by J. G. Taylor. [1958] 1v. incl. diagrs. refs. (Technical rept. no. 115, vol. 3) (AFOSR-TN-58-816c) (AF 49(638)24) AD 202641 Unclassified

Volume III contains the following topics: (1) summary of unsolved problems in dispersion relations; (2) analyticity properties of vacuum expectation values of field operators and the Wightman program; (3) the TCP theorem and the relation between spin and statistics; and (4) general analyticity property of vacuum expectation values of field operators.

MDU.16:019

Maryland U. [Dept. of Physics] College Park.

CONNECTION OF PHASE SHIFT AND POTENTIAL FOR THE DIRAC EQUATION (Abstract), by F. Prats and J. S. Toll. [1958] [1]p. [AF 49(638)24] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 36, Jan. 29, 1958.

Using a method of Gel'fand and Levitan, Jost and Kohn have shown how, for a Schrödinger equation with central potential, the potential can be determined (through the spectral function) by the phase shift, plus the energy and another arbitrary parameter for each bound state. A similar procedure is presented here, appropriately generalized to matrices, for the Dirac equation with a central potential with $\int_0^\infty r^m V(r) dr$ finite, ($m = 0, 1, 2$). From the analytic properties in the k -plane of the radial wave functions, a spectral function is introduced. The relation between eigenfunctions for two different potentials involves a kernel, from which the potential difference is obtained. The equation (analogous to the Gel'fand-Levitan integral equation) for this kernel can be constructed from the spectral function and eigenfunctions of the "comparison" potential and the spectral function for the unknown potential.

MDU.17:001

Maryland U. Dept. of Physics, College Park.

CALCULATION OF THE GRAND PARTITION FUNCTION OF AN INTERACTING BOSE GAS, TO THE FIRST ORDER IN THE SCATTERING LENGTH, by J. Peretti. [1958] 13p. incl. diagrs. (Technical rept. no. 119) (AFOSR-TN-58-982) (AF 49(638)399) AD 205875 Unclassified

It is shown that the method given by E. W. Montroll and J. C. Ward (item no. MDU.02:019) for dealing with quantum statistics of interacting particles can be applied to redrive some results for the Bose hard sphere given by Huang, Yang, and Lee. (Contractor's abstract)

MDU.17:002

Maryland U. [Dept. of Physics] College Park.

THE VIBRATION SPECTRA OF DISORDERED LATTICES, by C. Domb, A. A. Maradudin and others. Oct. 1958, 10p. (Technical note no. BN-153) (AFOSR-TN-58-1123) (AF 18(600)1315 and AF 49(638)399) AD 207832; PB 138509 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 8: 419-421, Jan. 1959.

Using the Moment-Trace method, the vibrational frequency spectrum of a randomly disordered, two-component, isotropic linear chain has been computed for a wide range of the concentrations of the two kinds of particles and of the mass ratio.

MDU.17:003; MDU.07:009;
MDU.08:007, 008

MDU.17:003

Maryland U. [Dept. of Physics] College Park.

FARADAY EFFECT IN METALS (Abstract), by E. A. Stern and R. D. Mvers. [1958] [1]p. [AF 49(638)399] Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 416, Dec. 29, 1958.

The rotation of the plane of polarization of light reflected normally from a nonferromagnetic metallic surface that has a magnetic field perpendicular to it is shown to be expected from theoretical grounds. This effect in a ten thousand gauss field is about one thousand times smaller than the corresponding magneto-optic-Kerr effect in ferromagnetic materials. From symmetry arguments this Faraday effect for cubic metals is independent of the orientation of the crystal axes to the surface normal. However, it does depend on an average effective mass of the valence band electrons and thus can be used to measure this effective mass. Experimental values of this effective mass will be given for a few metals whose Faraday effect has been measured. Since only an average effective mass is measured by the Faraday effect, no detailed information on the shape of the Fermi surface can be directly obtained by this means. However the technique can be used at practically any temperature and with alloys and thus can give information on those metals whose band structure can't be easily studied by other techniques.

MDU.07:009

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

TWO DIMENSIONAL JET MIXING OF SUPERSONIC FLOW, by S. I. Pal. [1954] [9]p. incl. illus. diagrs. refs. (AF 18(600)86) Unclassified

Published in Sonderdruck aus 50 Jahre Grenzschichtforschung, Festschrift, Braunschweig (Germany), Friedr. Vieweg and Sohn, 1954, p. 71-79.

Two-dimensional supersonic jet flows of air have been investigated by optical methods and the density functions measured and found to be error functions. In the cases of full expansion and over-pressure no interaction between the boundary layer flow and the core flow has been observed. The divergence of the jet mixing region decreases with increase of Mach number. In the case of an under-pressure distribution there is interaction between the boundary layer and the shock. The shock is curved and the flow field behind the shock is non-uniform. It has been shown experimentally that a two-

dimensional jet tends to be stable with respect to small disturbances at high Mach numbers.

MDU.08:007

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A NEW GOVERNING EQUATION OF SHOCK ANALYSIS WITH HEAT TRANSFER IN POLYATOMIC GASES (Abstract), by P. J. Theodorides. [1956] [1]p. [AF 18-(600)428] Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Mar. 19-21, 1956.

Published in Bull. Amer. Phys. Soc., Series II, v. 1: 361, Nov. 23, 1956.

In shock analysis, steep gradients of temperature and high divergence of the velocity vector seem to invite a widening of the viscosity concept for polyatomic gases by dropping the Stokes' hypothesis, and including nonlinear friction. Symmetrical stress matrices are developed with three independent physical parameters of gas friction, viz., one of linear bulk viscosity and one each of linear and nonlinear shear viscosity. The conservation equations for mass, momentum, and energy are set for triaxial, laminar supersonic flow of an isotropic, compressible, viscous, and heat-conducting gas. These relations are combined with the state equation, transformed, and specialized for uniaxial, steady flow. Thus a new governing equation of shock analysis is derived. The integration is discussed for temperature effects upon all three viscosity parameters, the heat conductivity, and specific heats. Though explicitly continuous, the present theory is implicitly linked to kinetic theory in expressing accordingly most of the physical parameters. Then, quantum dynamics hold, for $T > 600^\circ\text{K}$, as to energies in vibrational modes with proper frequencies and overtones from spectrometry. For nonlinear damping, no empirical data of separation are so far available. But the expediency is open to fill up, after Gilbarg and Paolucci, with molecular Burnett numbers of third approximation as based on Sonine polynomials.

MDU.08:008

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A BASIC APPROACH TO SHOCK FRONT ANALYSIS, by P. J. Theodorides, Jan. 1957, 31p. incl. diagr. refs. (Technical note no. BN-93) (AFOSR-TN-57-59) (AF 18-(600)428) AD 115099 Unclassified

Development of an approach suitable for a nonmonatomic fluid is discussed. The initial conditions provide for molecular vibration but assume only negligible dissociation, ionization or radiation of molecules. The basic

MDU.08:009 - MDU.08:012

equations for tri-axial flow are set on trimorous viscosity and specialized for steady, uni-axial flow. A new governing equation is derived for the shock front. Though explicitly continuous, the proposed theory harmonizes with the kinetic picture by expressing accordingly the nonlinear viscosity and the specific heats - the latter implying quantum dynamics as to vibratory modes. (This work is an extended version in English of a paper presented by the author before a Joint Conference of Committees on Fluid Dynamics Research in Göttingen (Germany) on Oct. 7, 1955 and published in ZAMM, Sonderheft 1956, p. 38-48.)

is a neighboring solution of Temple-Yarwood flow after slight modification of the inner boundary where the crown ($x = 0$) is slightly less convex than Temple-Yarwood case. The maximum Mach number in the modified flow is 1.600 as compared with 1.606 in the case of Temple-Yarwood flow; (2) the location of the sonic line shifts under the new inner boundary; (3) the new inner boundary is chosen to contain one point of zero curvature at the crown, where $x = 0$. A potential transonic solution is demonstrated by means of the relaxation method; and (4) the deviation from Temple-Yarwood channel flow becomes less and less as the outer boundary is approached. (Contractor's abstract, modified)

MDU.08:009

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

STRUCTURAL ANALYSIS OF HIGH SPEED WINGS FOR A QUASI TRI-AXIAL ELASTIC STATE IN THE SKIN, BIAXIAL IN THE LONGITUDINALS, by P. J. Theodorides. Feb. 1957, 19p. incl. diagr. refs. (Technical note no. BN-92) (AFOSR-TN-57-67) (AF 18(600)-428) AD 120409 Unclassified

Also published in Proc. Ninth Internat'l. Congress of Appl. Mech., Brussels (Belgium) (Sept. 5-13, 1956) v. 8: 71-85, 1957.

For aeroelastic efficiency, fast flight favors thin wings of low aspect ratio and utmost rigidity - either delta-shaped, or swept, or straight. This and economy in alar mass are met by a composite class of wing design. Then, stiffened skin plates resist mainly normal strain from flexure, while thin webs and ribs, densely spaced, take most of the shear. For wings of such form and texture, an improved plate theory may be a sound basis of structural analysis. Elastic interplay of skin and stiffeners is accounted for, in present work, with care of avoiding both intricacies of thick skin theory and defects in Kirchhoff's way.

MDU.08:011

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

TRANSONIC FLOW AFTER SLIGHT MODIFICATION OF SMOOTH CONTOUR, by C.-C. Chang and W.-H. Chu. [1957] [11p. [In cooperation with Minnesota U. Dept. of Aeronaut. Engineering under AF 18(600)1456] [AF 18(600)428] Unclassified

Published in Proc. Ninth Internat'l. Congress Appl. Mech., Brussels (Belgium) (Sept. 5-13, 1956), v. 2: 80, 1957.

The non-existence of transonic potential flow after slight smooth modification of contour was recently treated by Guderley (Advances in Appl. Mech., Academic Press, v. 3, 1953, p. 145-184). With both linearized hodograph differential equation and boundary conditions, it is difficult to make a convincing argument with his approximate approach. The present paper is an example of the resultant transonic flow after slight, smooth modification is made. The original channel flow is a portion of Temple-Yarwood flow, in which local supersonic flow symmetrically with respect to y-axis occurs along the central portion of convex curved wall. Then, the convex curved wall is slightly modified to maintain the following features: (a) the resultant curved wall has all continuous derivatives; (b) only the central portion is modified slightly; and (c) the resultant channel wall is still symmetrical with respect to y-axis. The resultant flow is calculated by means of relaxation method. To the accuracy of 1/100 of Mach number, the new transonic flow is still potential, and symmetrical with respect to y-axis. No shock is found. (Contractor's paper)

MDU.08:010

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

TRANSONIC CHANNEL FLOW AFTER SLIGHT MODIFICATION OF INNER BOUNDARY, by C.-C. Chang and W.-H. Chu. [1957] [11p. incl. diagrs. refs. [In cooperation with Minnesota U. Dept. of Aeronaut. Engineering under AF 18(600)1456] [AF 18(600)428] Unclassified

Published in Proc. Ninth Internat'l. Congress Appl. Mech., Brussels (Belgium) (Sept. 5-13, 1956), v. 2: 50-60, 1957.

It is found that: (1) within the accuracy of $\Delta M = \pm 0.01$, there exists a potential transonic channel flow which

MDU.08:012

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE SHOCK WAVE IN A NON-MONATOMIC FLUID, by P. J. Theodorides. Feb. 1958, 20p. incl. diagrs. tables, refs. (Technical note no. BN-123) (AFOSR-TN-58-156) (AF 18(600)428) AD 152182 Unclassified

MDU.08:013, 014; MDU.09:054, 055

Also published in Helvetica Physica Acta, v. 31: 33-42, Nov. 15, 1958.

Analysis of the structure of shock profiles using conservation equations of mass, momentum, and energy which are specialized for a uni-axial steady flow taken initially as supersonic under stratospheric conditions. Boundary conditions for normal shock of varied strength are calculated for variable enthalpy. The shock waves in molecular nitrogen are given in tabular form. A graphical representation of shock transition and of shock wave profiles in molecular nitrogen is made. Results indicate that the temperature effects increase considerably the shock thickness in the velocity profile, and that a broadening of about 43% is added on account of bulk viscosity from ultrasonic measurements.

MDU.08:013

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

INVESTIGATION OF FACTORS AFFECTING THE CONTROL AND STABILITY OF HIGH SPEED AIRCRAFT AND MISSILES, by P. J. Theodorides. Final rept. Sept. 1, 1952-Feb. 28, 1958. Apr. 1958 [12]p. incl. refs. (Technical rept. no. BN-129) (AFOSR-TR-58-52) (AF 18(600)428) AD 154215 Unclassified

Work conducted for the contract was reviewed under the headings of (1) basic theory in fluid dynamics; (2) aerodynamics of unsteady flow; (3) elasticity of high-speed wings; and (4) shock analysis in nonmonatomic media. An annotated bibliography arranged in chronological order, by year, is presented for 14 reports and publications which are related to the contract investigation. Significant findings are detailed on the width of shock transition in N_2 for several intensities of normal shock,

high enough to unfreeze quantized vibration with negligible dissociation and ionization. Separation was made of the effects of the viscosities (linear shear friction, bulk viscosity) on the profiles (velocity, temperature) by alternate use of either Stokes' hypothesis or bulk viscosity data from ultrasonics. Numerical values for the shock width in the speed profile of N_2 were revealed as of the order of $d_u = (1.68) \cdot 10^{-6}$ m for $M_1 \sim 2.18$ and $d_u = (1.00) \cdot 10^{-6}$ m for $M \sim 4.99$ (accounting for bulk viscosity), while Stokes hypothesis ($K = 0$) yielded $(1.18) \cdot 10^{-6}$ m and $(0.69) \cdot 10^{-6}$, respectively. (ASTIA abstract)

MDU.08:014

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

PARALLEL EFFECTS OF BULK VISCOSITY AND

TIME LAG IN KINETICS OF NON-MONATOMIC FLUIDS, by P. J. Theodorides. [1958] [19]p. incl. refs. (AF 18-(600)428) Unclassified

Published in Zeitschr. Angew. Math. Phys., v. 9B: 668-686, Mar. 25, 1958.

The author considers the bulk viscosity and time lag in the kinetics of non-monatomic fluids involving one inner process such as a single mode of vibration within molecules. For a triaxial flow with trimorous viscosity, equations of motion, continuity, and energy have been derived, and effects of bulk viscosity and quadratic shear viscosity on the Navier-Stokes equations are discussed. Utilizing the data on bulk viscosity for molecular nitrogen from ultrasonic measurements, the end state characteristics of shock waves have been calculated.

MDU.09:054

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

LOWER BOUNDS FOR ELASTICALLY SUPPORTED MEMBRANES AND PLATES, by L. E. Payne and H. F. Weinberger. Apr. 1957, 18p. (Technical note no. BN-96) (AFOSR-TN-57-176) (AF 18(600)573) AD 126471 Unclassified

An analysis is made to define explicit lower bounds for the eigenvalues of several problems of physical interest. Such bounds are given for the vibration frequencies of elastically supported plates and membranes in terms of quantities that are easily computed.

MDU.09:055

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

REFLECTION PRINCIPLES FOR SOLUTIONS OF EQUATIONS IN ELASTICITY, by J. H. Bramble. Aug. 1957, 58p. refs. (Technical note no. BN-106) (AFOSR-TN-57-499) (AF 18(600)573) AD 136489 Unclassified

Certain reflection principles are established for bi-harmonic functions which arise as solutions of equations in elasticity. The most general region D for which the principles are valid are not given; however, it should be noted that all results remain valid if D is chosen to be the intersection of D^* (the 2(3)-dimensional region which excludes the origin but contains a portion of a circle (sphere) of radius a with center at the origin) with $r \geq a$ and required to be finite; r is the distance from a point to the origin of the coordinate system. Certain theorems are proved which are applicable in presenting the formulas which establish the reflection principles; the sliding clamp condition is also considered. The continuations for the solutions of the elasticity equations are given in the case where the displacements

MDU.09:056 - MDU.09:059

vanish on a circular arc or spherical surface in 2 or 3 dimensions, respectively. In the case where the normal stresses vanish on a circular arc, a continuation formula for stresses is obtained.

MDU.09:056

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NEW BOUNDS FOR SOLUTIONS OF SECOND ORDER ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS, by L. E. Payne and H. F. Weinberger. Sept. 1957 [41]p. incl. diagr. refs. (Technical note no. BN-108) (AFOSR-TN-57-651) (AF 18(600)573) AD 136636 Unclassified

Also published in Pacific Jour. Math., v. 8: 551-573, 1958.

A generalization of Rellich's (Math. Zeltschr., v. 46: 635-646, 1940) identity to a large class of elliptic systems of second-order differential operators is employed to extend the results obtained previously (Jour. Math. and Phys., v. 4: 291-307, 1955) to equations involving such operators and rather general domains. Only the case of a single self-adjoint second-order operator without zero order term is treated in detail, but the results are extended to a class of nonself-adjoint second-order equations as well as a large class of elliptic systems of second-order differential equations. The identity is discussed and used to estimate several quadratic functions including the generalized Dirichlet integral in terms of Dirichlet data for a general nonhomogeneous boundary value problem in N dimensions. An approximation to the generalized Dirichlet integral is obtained by means of a functional of an arbitrary function. The error estimate is a quadratic functional in the deviation of the Dirichlet data of the arbitrary function from the given data. A general differential equation is considered with a provision made for an error of the arbitrary function both in the differential equation and in the boundary values, and the error estimate is a quadratic functional in both. The value of the solution of a Dirichlet problem at an arbitrary interior point is also given, and estimates are derived for the exterior Neumann problem in 3 or more dimensions.

MDU.09:057

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ORDERING AND UNIQUENESS OF SOLUTIONS OF BOUNDARY PROBLEMS FOR ELLIPTIC EQUATIONS, by C. Pucci. Oct. 1957, 13p. (Technical note no. BN-112) (AFOSR-TN-57-690) (AF 18(600)573) AD 136684 Unclassified

Dirichlet, Neuman third and mixed problems are considered for the second order elliptic partial differential

equation of a general type. Ordering and uniqueness theorems are obtained as consequences of the maximum-minimum properties of the solutions of elliptic equations in the interior of the set T in which they are defined and on the boundary of T . An elliptic partial differential equation, $f(x, u, u_1, u_{11}) = 0$ is considered, which can

have singularities on the boundary of T and also at interior points of T . This means that in a neighborhood of some points x the first derivatives of f with respect to u and u_1 can be unbounded and, at these points x , u can

be without second derivatives and can have discontinuous first derivatives. Furthermore it is supposed that the equation can be of parabolic type on some hypersurfaces belonging to T . The hypotheses considered in this paper with regard to the equation and the class of solutions are in some way essential as is shown by four examples (C. Pucci, Atti. Accad. Naz. Lincei, 1957); in this generality the results are new even with regard to the Dirichlet problem.

MDU.09:058

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

REMARK ON A PAPER OF O. G. Owens, by L. E. Payne and H. F. Weinberger. [1957] [1]p. [AF 18(600)-573] Unclassified

Published in Duke Math. Jour., v. 24: 233, June 1957.

O. G. Owens (Duke Math. Jour., v. 23: 371-383, 1956) showed that if $u(x, y, t)$ is the solution of the wave equation $u_{tt} = u_{xx} + u_{yy}$ taking the values of a homogeneous polynomial $\psi(x, y)$ on the characteristic cone $(t^2 - x^2 - y^2 = 0)$, then u is a homogeneous polynomial in (x, y, t) of the same degree as ψ . A much simpler proof is given in this note by exhibiting $u(x, y, t)$ explicitly.

The problem is solved for the value $\psi = x^p y^q$.

MDU.09:059

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

LOWER BOUNDS FOR VIBRATION FREQUENCIES OF ELASTICALLY SUPPORTED MEMBRANES AND PLATES, by L. E. Payne and H. F. Weinberger. [Dec. 1957] [12]p. incl. diagr. (AF 18(600)573) Unclassified

Published in Jour. Soc. Indust. Appl. Math., v. 5: 171-182, Dec. 1957.

This paper is concerned with explicit lower bounds for the eigenvalues of several problems of physical interest. The following are some of the items given consideration:

(1) the eigenvalue problem on a bounded region; (2) the computed lower bound for any two-dimensional bounded

MDU.09:060 - MDU.09:063

region and the analog for a three-dimensional one; (3) problems which arise in the theory of the transverse vibrations of thin elastically supported plates; and (4) lower bounds for all the eigenvalues of a plate in terms of eigenvalues of membranes as well as one-dimensional problems.

MDU.09:060

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NOTE ON A LEMMA OF FINN AND GILBARG, by L. E. Payne and H. F. Weinberger. [1957] [3]p. (AF 18(600)-573) Unclassified

Published in Acta Math., v. 98: 297-299, 1957.

This paper has the same context as a prior paper of Finn and Gilbarg, "Three-dimensional Subsonic Flows, and Asymptotic Estimates for Elliptic Partial Differential Equations" (Acta Math., v. 98: 265-296, 1957). It is shown that if u satisfies $(a^{ij}u_{,j})_{,i} = 0$, and is such that a^{ij} (which depends on u) approaches the unit matrix of order n at infinity, then $\int a^{ij}u_{,j}dV$, over the region outside a sphere of radius r , is for large r of order $r^{2-n+0(1)}$. This is essentially a sharp result because for Laplace's equation the order is r^{2-n} .

MDU.09:061

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

ON A CAUCHY PROBLEM WITH SUBHARMONIC INITIAL VALUES, by A. Weinstein. [1957] [16]p. (AF 18(600)573) Unclassified

Published in Ann. Mat. Pura Appl., v. 43: 325-340, 1957.

This paper deals with the singular Cauchy problem for a Euler-Poisson-Darboux equation with non-negative index. The first part of this paper consists of an investigation of the properties of solutions of our Cauchy problem under the assumption that the initial data satisfy a differential equation of the Helmholtz type. In the second part the EPD equation is transformed into a generalized Tricomi equation in several variables. This could be used in the theory of subharmonic functions. Finally, classical theorems of Riesz and Montel on mean values of subharmonic functions are extended.

MDU.09:062

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

[ON THE ISOPERIMETRIC INEQUALITY OF CURVED AREAS] Zur isoperimetrischen Ungleichung auf gekrümmten Flächen, by A. Huber. [1957] [7]p. incl. refs. (AF 18(600)573) Unclassified

Published in Acta Math., v. 97: 95-101, 1957.

The author gives a simple proof of the following result, which he has previously [Ann. Math., v. 60: 237-247, (1954); v. 63: 572-587, (1956)] presented in somewhat less general form. Let a conformal metric $ds = e^{u(z)}|dz|$ be defined on a Riemann surface R , and suppose that $u(z)$ can be represented locally as the difference of two subharmonic functions $u(z) = u_1(z) - u_2(z)$. Let γ be a locally rectifiable Jordan curve on R , enclosing a simply connected domain ω . Let $\mu_2(e)$ be the measure associated with $u_2(z)$, and write $\mu_2(\omega) = \alpha$. Then the following inequality holds:

$$\left(\int_{\gamma} e^{u(z)} |dz| \right)^2 \geq 4\pi(1 - \alpha) \iint_{\omega} e^{2u} dx dy,$$

where $z = x + iy$; the sign of equality is valid if and only if $\alpha < 1$ and $u(z) = \log |\Phi(z)(\Phi(z))^{-\alpha}| + c$, where $w = \Phi(z)$ is an arbitrary conformal map of ω on $|w| < 1$ and c is an arbitrary real constant. (Math. Rev. abstract)

MDU.09:063

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON DISCONTINUOUS INITIAL VALUE PROBLEMS FOR CERTAIN NON-LINEAR PARTIAL DIFFERENTIAL EQUATIONS, by A. Douglis. Feb. 1958, 25p. incl. refs. (Technical note no. BN-112) (AFOSR-TN-58-165) (AF 18(600)573) AD 152192 Unclassified

The partial differential equations discussed are of the form $\frac{\partial u}{\partial t} + \frac{\partial F(u)}{\partial x} = 0$, where $F(u)$ is a continuously differentiable and convex function. Even though non-linear equations of the above type have discontinuities in the Cauchy solution, a meaningful solution can be obtained by accepting a condition of an integral type. The initial data admitted are bounded, measurable functions on the x -axis vanishing for $x < 0$. The integral type solutions have been found previously but are presently obtained by a method involving differencing in one direction which, it is hoped, may lend itself to a generalization. A difference quotient is obtained for the integral condition which leads to a recursive system of ordinary differential equations replacing the original equation. The difference quotients are shown to be bounded and to

MDU.09:064 - MDU.09:067

satisfy a form of the "entropy condition". The proof is completed from general theorems on the class of bounded functions subject to such an entropy condition.

MDU.09:064

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

REPRESENTATION FORMULAS FOR SOLUTIONS OF A CLASS OF PARTIAL DIFFERENTIAL EQUATIONS, by L. E. Payne. Feb. 1958, 18p. (Technical note no. BN-122) (AFOSR-TN-58-197) (AF 18(600)573) AD 152230 Unclassified

Also published in Jour. Math. and Phys., v. 38: 145-149, July 1959.

Decomposition formulas are obtained for the solution u of the equation $L_{\alpha_1} L_{\alpha_2} L_{\alpha_3} \dots L_{\alpha_m} (u) = 0$, where the

operator $L_{\alpha_k} (v) = \frac{\partial^2 v}{\partial y^2} + \frac{\alpha_k}{y} \frac{\partial v}{\partial y} \pm \sum_{i=1}^{n-1} \frac{\partial^2 v}{\partial x_i^2}$, and the

α_k are any real numbers and m and n are arbitrary positive integers. (Contractor's abstract)

MDU.09:065

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

MEAN VALUE THEOREMS IN THE THEORY OF ELASTICITY, by J. B. Diaz and L. E. Payne. Jan. 1958, 30p. incl. refs. (Technical note no. BN-117) (AFOSR-TN-58-261) (AF 18(600)573) AD 154165 Unclassified

Also published in Proc. Third U. S. Nat'l. Congress of Appl. Mech., Brown U., Providence, R. I. (June 11-14, 1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 293-303.

Grüss' mean value theorem of potential theory states that if a function is harmonic on a sphere plus its interior, then the value at the center of a sphere equals the arithmetic mean of the values of the function on the surface of the sphere. In this paper several of the possible mean value theorems of the theory of elasticity are obtained. The method of derivation employed works simultaneously in the physically interesting cases of two and three dimensions, as well as in higher dimensions. (Contractor's abstract)

MDU.09:066

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

AN ORDERING PRINCIPLE AND GENERALIZED SOLUTIONS OF CERTAIN QUASI-LINEAR PARTIAL DIFFERENTIAL EQUATIONS, by A. Douglis. May 1958, 39p. incl. refs. (Technical note no. BN-136) (AFOSR-TN-58-456) (AF 18(600)573) AD 158283; PB 135160 Unclassified

Also published in Commun. on Pure and Appl. Math., v. 12: 87-112, Feb. 1959.

Let $F(u)$ be continuously differentiable and convex. By a "generalized" solution in the half plane $t \geq 0$ of the partial differential equation (1) $u_t + (F(u))_x = 0$ is meant

a solution in an appropriate integral sense which satisfies the "entropy" condition (2) $u(x-0, t) \leq u(x+0, t)$ for $t > 0$. Under the additional hypothesis that F'' is integrable and is restricted by an inequality of the form (3) $a \leq F''(u) \leq b$, where $a = \text{const.} > 0$, $b = \text{const.}$, generalized solutions of (1) are constructed with arbitrary, bounded, measurable initial data which actually satisfy a sharper form, namely, (4) $u(x+h) - u(x) \leq h/at$ for $h > 0$, $t > 0$, of (2). Such solutions, moreover, are governed by the following ordering principle: If $u_1(x, t)$ and $u_2(x, t)$ are any two such solutions, and if $u_1(x, 0) \leq u_2(x, 0)$ for almost every value of x , then $u_1(x, t) \leq u_2(x, t)$ for every $t > 0$ and every x .

This principle is made the basis of existence and uniqueness theorems, when (3) is presumed, and, in a more restrictive form, of existence theorems alone, when (3) is not presumed.

MDU.09:067

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON LINEAR, HYPERBOLIC EQUATIONS OF SECOND ORDER, by A. Douglis. June 1958, 25p. (Technical note no. BN-139) (AFOSR-TN-58-558) (AF 18(600)573) AD 158376; PB 135575 Unclassified

A new means is presented of reducing to an integral equation Cauchy's problem for a linear, hyperbolic, partial differential equation of second order with variable, not necessarily analytic, coefficients. The new method is a relatively direct one, avoids severely singular auxiliary functions, avoids analytic continuation, and is applicable equally to the cases of an even or of an odd number of independent variables without need for descent. (Contractor's abstract)

MDU.09:068, 069; MDU.10:007, 008

MDU.09:068

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

[PROPERTIES OF THE MAXIMA AND MINIMA OF THE SOLUTIONS OF ELLIPTIC AND PARABOLIC SECOND ORDER PARTIAL DIFFERENTIAL EQUATIONS, PARTS I AND II] Proprietà di massimo e minimo delle soluzioni di equazioni a derivate parziali del secondo ordine di tipo ellittico e parabolico, Nota I, II, by C. Pucci. [1957 and 1958] 10p. incl. refs. (AF 18-600)573) Unclassified

Published in Atti Accad. Naz. Lincei. Rend. Cl. Sci. Fis. Mat. Nat., Series VIII, v. 23: 1-6, Dec. 1957; v. 24: 3-6, Jan. 1958.

The general second order partial differential equation $L(u) = 0$ is discussed. A theorem is given, which is a generalization of a result given by E. Hopf for elliptic equations and L. Nirenberg for parabolic equations, and is essentially the following. Let u be a real function of class C^2 in S , an open sphere in R^m , with center at η and radius r_0 for which $L(u) \leq 0$ in S and u is continuous in \bar{S} . Let x^0 be a point of the boundary of S where $u(x^0) \leq 0$ such that, for all $x \in S$, $u(x) < u(x^0)$. If the coefficients satisfy certain conditions, then the lower limit of the ratio $[u(x) - u(x^0)]/\sqrt{xx^0}$, for $x \in$ a segment in S terminating at x^0 , is positive. A second theorem concerns conditions under which u can attain a maximum or minimum in the region. From these two theorems, various corollaries are given, such as the fact that when $c = 0$, u has no maximum or minimum in the interior of T .

MDU.09:069

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

CONTINUATION OF BIHARMONIC FUNCTIONS ACROSS CIRCULAR ARCS, by J. H. Bramble. [1958] [20]p. incl. refs. (AF 18(600)573) Unclassified

Published in Jour. Math. and Mech., v. 7: 905-924, Nov. 1958.

This paper establishes certain reflection principles (analogous to the classical Schwarz reflection principle for harmonic functions) for biharmonic functions subject to various boundary conditions. Explicit formulae are given for the continuation of a biharmonic function w across a circular arc Q when the following conditions are satisfied:

- (A) $w = M(w) = 0$ on Q ,
- (B) $M(w) = V(w) = 0$ on Q ,
- (C) $w_r = V(w) = 0$ on Q ,

where

$$M(w) = \Delta w + \frac{1-\sigma}{\sigma} w_{rr}$$

$$\text{and } V(w) = \frac{\partial}{\partial r} (\Delta w) + (1-\sigma) \frac{1}{2} \left[w_{\theta\theta} + \frac{1}{r} w_{\theta\theta} \right],$$

Δ being the Laplace operator and a the radius of the circle. If σ is taken to be Poisson's ratio, then (A) and (B) correspond physically to the cases where Q is the edge of an elastic plate which is "simply supported" and "free" respectively. Condition (C) corresponds to the so called "sliding clamped" case. (Contractor's abstract)

MDU.10:007

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

EXPERIMENTAL STUDY OF DETAIL PHENOMENA OF TRANSITION IN BOUNDARY LAYERS: ON STEADY FLOW PATTERNS APPEARING WHEN A SINK IS COMBINED WITH BOUNDARY LAYER FLOW, AND ADDITIONAL NOTES, by J. R. Weske, J. M. Burgers and others. Feb. 1957, 1v. incl. illus. diagrs. tables, refs. (Technical note no. BN-91) (AFOSR-TN-57-62) (AF 18(600)893) AD 120403 Unclassified

In presenting and correlating the results of visual and photographic studies of the process of transition from laminar to turbulent flow on a flat plate, evidence is furnished which tends to prove that, whatever the original cause initiating transition, i.e., whether point disturbance, two-dimensional periodic excitation or steady adverse pressure gradient, the observed motions are so closely alike that the sequence of individual processes composing the chain of events which constitute the breakdown of laminar flow and the origin and spread of turbulence may be regarded as a universal characteristic of boundary layer transition. Three appendices are included.

MDU.10:008

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE STABILITY OF LAMINAR FLOW WITH THREE-DIMENSIONAL DISTURBANCES, by G. Jungclauss. Sept. 1957 [13]p. incl. diagrs. (Technical note no. BN-'10) (AFOSR-TN-57-577) (AF 18(600)893) AD 136565 Unclassified

Earlier work on laminar instability to three-dimensional disturbance by Squire (Proc. Roy. Soc., v. 142A: 1933) and its extension by Kuethe (Proc. First Midwestern Conf. on Fluid Dynamics, 1950) is used to show that standing three-dimensional waves are possible in the case of artificial excitation and that they may occur in channels of finite width. For the yawed plate disturbance waves in direction of undisturbed flow are amplified most.

MDU.10:009 - MDU.10:012

MDU.10:009

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

CALCULATION OF THE CROSS-STREAM WAVE LENGTH OF THE THREE-DIMENSIONAL TRANSITION PATTERN AND CORRELATION WITH THE GORTLER INSTABILITY THEORY, by J. R. Weske and Y. Y. Chen. Oct. 1957 [31]p. incl. illus. diagrs. (Technical note no. BN-111) (AFOSR-TN-57-637) (AF 18(600)893) AD 136625 Unclassified

A theory is explained concerning the mechanism which, at an early stage of transition in the boundary layer, produces a regular 3-dimensional pattern. A discussion is presented of the cross-stream wave length with consideration given to (1) the generation of secondary vorticity along a curved streamline in the boundary layer, (2) the structure of the vortex sheet of secondary vorticity (3) computation of the field of induced velocities produced by the vortex sheet, (4) establishment of relationships for the cross-stream wave length, (5) the influence of the static pressure gradient in the direction of the mean flow and of variation of the Reynolds number, and (6) the relation between the sheet of secondary vorticity and the formation of longitudinal vortices. The secondary-vorticity relations for the case of rotational yet nonviscous flow are used to derive quantitative relationships for the cross-stream wave length of this pattern for uniform and for retarded free flow. Certain of the results are correlated with boundary layer and instability theory along curved walls by Taylor and Gortler. Comparison is made with available experimental results. (ASTIA abstract)

MDU.10:010

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON STEADY FLOW PATTERNS APPEARING WHEN A SINK IS COMBINED WITH BOUNDARY LAYER FLOW, by J. M. Burgers. [1957] 14p. diagrs. (Bound with its AFOSR-TN-57-62; AD 120403 as Appendix I) [AF 18(600)893] AD 120403(a) Unclassified

The description of steady flow patterns appearing when a sink is combined with boundary layer flow is compared to a two dimensional case justified by a case where fluid motion is slow relative to the speed of rotation of the system. Sheets of discontinuity in the field of flow (implemented by neglect of the viscosity effects) are studied with the assumption, that in the case of the boundary layer along a wall, the vorticity already present in the original undisturbed flow might act in a way comparable to the effect of the rotation in Taylor's experiments, and also that in the boundary layer case sheets of discontinuity might make their appearance. The observed tendency of dye streamers in a shear layer to spread out in the plane of principal shear is discussed.

MDU.10:011

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

CHANGE OF THE LAMINAR BOUNDARY LAYER PROFILE THROUGH A PRESSURE DECREASE, by Y. Y. Chen. [1957] 3p. diagrs. (Bound with its AFOSR-TN-57-62; AD 120403 as Appendix II) [AF 18(600)893] AD 120403(b) Unclassified

A laminar boundary layer profile approximated by the relation is given

$$u_1 = U_1 \left(\frac{z_1}{\delta_1} \right)^{\frac{1}{2}}$$

where δ_1 = boundary layer thickness

U_1 = free stream velocity

Let there be a pressure drop between Station 1 and 2,

$$p_1 - p_2 > 0$$

Because of this pressure drop the flow will be accelerated both in the boundary layer and the free stream. As a result, the boundary layer will decrease in thickness and the streamlines will draw closer to the wall. The changes of the velocity profile brought about by the decrease of static pressure and in particular the ratio of distance from the wall of the streamlines $z_2/z_1 < 1$ will

be calculated. Disregard fluid friction in the process, also assume incompressibility. Since viscous action is disregarded, Bernoulli's equation holds along streamlines.

MDU.10:012

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

UPSTREAM EFFECT OF A TWO-DIMENSIONAL OBSTACLE UPON THE LAMINAR BOUNDARY LAYER ALONG A FLAT PLATE, by G. Jungclaus. [1957] 6p. diagrs. tables. (Bound with its AFOSR-TN-57-62; AD 120403 as Appendix III) [AF 18(600)893] AD 120403(c) Unclassified

A two-dimensional incompressible flow past a flat plate is given, on which, at a distance x_0 from the leading edge, has been placed a two-dimensional obstacle, a bar of height h . The height h is of the order of magnitude of the boundary layer thickness. The influence of the obstacle upon the flow upstream is determined. The potential flow is calculated and the boundary layer is computed.

MDU.10:013-015; MDU.11:016, 017

MDU.10:013

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE ORIGIN AND MECHANISM OF VORTEX MOTION AT THE INLET OF INTAKES PLACED NEAR A FLAT SURFACE, by J. R. Weske. Nov. 1958 [24]p. incl. illus. diagrs. (Technical note no. BN-152) (AFOSR-TN-58-863) (AF 18(600)893) AD 203672
Unclassified

The mechanism by which a vortex is formed in the field of a sink which is located close to a solid surface is investigated and it is shown that the various forms which the vortex assumes can be related to the same pattern. Secondary vorticity has been found to be the link between the vorticity of the undisturbed boundary layer and the vorticity of the observed vortices. The optimum stream velocity for the generation of a vortex sink is investigated both theoretically and experimentally.

MDU.10:014

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

CALCULATION OF THE CROSS-STREAM WAVE LENGTH OF THE THREE-DIMENSIONAL TRANSITION PATTERN IN THE BOUNDARY LAYER ALONG A FLAT PLATE, by J. R. Weske. Nov. 1958, 16p. incl. illus. diagrs. refs. (Technical note no. BN-150) (AFOSR-TN-58-864) (AF 18(600)893) AD 203671
Unclassified

Observed three-dimensional transition motions in the boundary layer showing a pronounced pattern recurring periodically across the stream are analyzed under the assumption that secondary vorticity is a controlling factor and that viscous effects are of minor consequence. An optimum cross-stream wave length was computed which is numerically in agreement with experimental observations. The results of the computation point to the emergence of composite periodic vortex configurations. (Contractor's abstract)

MDU.10:015

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

TRANSITION FLOW PATTERNS, by J. R. Weske. Final technical rept. Nov. 1958, 4p. (AFOSR-TR-58-130) (AF 18(600)893) AD 203685
Unclassified

Flow patterns were investigated in horseshoe vortex patterns, periodic stable longitudinal vortices and cross-stream vortices. Experiments were made in the boundary layer along a flat plate over which in a deep stream of water laminar boundary layers were maintained at

Reynolds numbers up to $Re = 800,000$. Investigation was also made of flow patterns in the boundary layer leading to transition brought about by roughness elements placed on the plate. The horseshoe pattern by manipulation of adverse pressure gradients, was transmuted into one of longitudinal vortices on one hand and of cross-stream vortices on the other. A theoretical method of calculation of the cross-stream wave length was devised by which the optimum wave length was computed, its order of magnitude agreeing with experimental observations. Observations of strong secondary flows within the vortices stimulated the theoretical investigation of the process of stretching of vortices. (ASTIA abstract)

MDU.11:016

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

JET MIXING OF TWO COMPRESSIBLE FLUIDS, by S. I. Pal. [1955] 3p. (AF 18(600)993) Unclassified

Published in Zeitschr. Angew. Math. Mech. (ZAMM), v. 35: 1-3, Sept./Oct. 1955.

The problem of the mixing region of laminar flow of a jet of one perfect gas into the jet of another perfect gas such that chemical reaction is possible is considered. The problem is reduced to the solution of second order differential equations for the power series components of the concentration and temperature. (See also item no. MDU.11:005)

MDU.11:017

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SELECTED TOPICS FROM THE THEORY OF GAS FLOW AT HIGH TEMPERATURES (III), by J. M. Burgers. Mar. 1957, 65p. (Technical note no. BN-99) (AFOSR-TN-57-284) (AF 18(600)993) AD 132355
Unclassified

This third part considers problems of gas flow in which account is taken of diffusion. Attention is given to the production or disappearance of molecules in consequence of chemical reactions. The diffusion has been treated on the basis of a method developed by M. Krook (Phys. Rev., v. 99: 1896-1897, 1955), leading to equations of a relatively simple structure. The method operates with certain mean values for the collision frequency in which no account is taken of the variations in speed of the molecules. An extension is indicated which brings a partial correction for effect of the speed. (Contractor's abstract) (See also item nos. MDU.11:011 and MDU.11:013 for Parts I and II)

MDU.11:018 - MDU.11:022

MDU.11:018

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

HYPERSONIC VISCOUS FLOW OVER A WEDGE, by S. I. Pai and S. F. Shen. [1957] [14]p. incl. diagrs. refs. (AFOSR-TN-57-361) (AF 18(600)993) AD 109841
Unclassified

Also published in Proc. Fourth Midwestern Conf. on Fluid Mechanics, Purdue U., Lafayette, Ind. (Sept. 8-9, 1955), Lafayette, Purdue U. Engineering Experiment Station (Research Series no. 128), [1956] p. 259-272.

A general discussion of the problem of hypersonic viscous flow over an inclined wedge with heat transfer is given, in which the flow over an insulated flat plate is a special case. The skin friction, heat transfer coefficient as well as induced pressure distribution due to interaction of boundary layer flow and outside inviscid fluid flow, shock wave or expansion wave, are calculated by a generalized von Karman integral method for the boundary layer equations of a compressible fluid. A brief comparison of the present method with several other theoretical methods as well as some experimental data for special cases is given. The interaction phenomenon has profound effects on the skin friction, induced pressure distribution and heat transfer coefficients.

MDU.11:019

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SELECTED TOPICS FROM THE THEORY OF GAS FLOW AT HIGH TEMPERATURES (IV), by J. M. Burgers. July 1957, 26p. (Technical note no. BN-103) (AFOSR-TN-57-459) (AF 18(600)993) AD 136450; PB 135855
Unclassified

This fourth part considers the construction and solution of equations of transfer. First a simplified account of Kenberry and Truesdell's development of the method of equation of transfer is given, so as to make it applicable to the calculation of higher approximations. Then part of Truesdell's formalism starting from Krook's simplified collision equation is developed so that the results will not be based exclusively on the Maxwellian case. (See item no. MDU.11:017 for Part III)

MDU.11:020

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE PENETRATION OF A SHOCK WAVE INTO A MAGNETIC FIELD, by J. M. Burgers. June 1957, 84p.

incl. diagrs. (Technical note no. BN-102) (AFOSR-TN-57-527) (AF 18(600)993) AD 136511
Unclassified

Consideration is given to a number of problems which present themselves when a plane shock wave moving in a gas of high electric conductivity approaches a magnetic dipole field. The subject is treated in a number of steps: first the conductivity is considered to be infinite and the reaction of the magnetic field upon the motion of the gas is neglected; in this way a provisional picture of the distortion of the magnetic field by the shock wave can be obtained. In the next part of the paper the conductivity is treated as finite, although large; in the third part the effect of the magnetic field upon the motion of the gas in the immediate neighborhood of the shock front is investigated. In part IV some considerations are developed concerning the reaction of the magnetic field upon the propagation of the wave; while part V brings a tentative discussion of the possibility of a steady field of flow. (Contractor's abstract)

MDU.11:021

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SHOCK WAVE PROPAGATION IN AN INFINITELY ELECTRICALLY CONDUCTIVE GAS WITH TRANSVERSE MAGNETIC FIELD AND GRAVITATION, by S. I. Pai. Sept. 1957, 1v. incl. diagrs. (Technical note no. BN-109) (AFOSR-TN-57-578) (AF 18(600)993) AD 136566
Unclassified

Also published in Zeitschr. Angew. Math. Mech. (ZAMM), v. 39: 40-49, Jan./Feb. 1959.

The behavior of a one dimensional strong shock wave propagating itself in an infinitely electrically conductive gas in the presence of a transverse magnetic field and of gravity has been analyzed by means of the Lagrangian method. The effect of the magnetic field is to increase the speed of the shock wave and the domain influenced by the shock wave. A brief description of the characteristics of the same problem from the Eulerian point of view is also given. (Contractor's abstract)

MDU.11:022

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

PROPERTIES OF HIGH TEMPERATURE ARGON BEHIND STRONG SHOCK WAVES MEASURED WITH A CAPACITIVE PROBE, by H. D. Weymann. Oct. 1955 [27]p. incl. illus. diagrs. refs. (Technical note no. BN-62) (AFOSR-TN-57-774) (AF 18(600)993) AD 148004
Unclassified

A description is presented of a capacitive probe which is sensitive to the thickness of the boundary layer, when

MDU.11:023 - MDU.11:026

the gas in the undisturbed flow is ionized. This probe can be placed outside a shock tube, thus avoiding disturbances in the flow. Preliminary results for Ar at Mach numbers between 6 and 10, and temperatures between 6000° and 9000°K show the usefulness of the probe for measuring the thickness of the boundary layer, the rate of ionization behind the shock front, and the coefficient of diffusion. (Contractor's abstract)

MDU.11:023

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ENERGY EQUATION OF MAGNETO-GAS DYNAMICS, by S. I. Pai. Preliminary paper. Jan. 4, 1957, 12p. illus. (AF 18(600)993) Unclassified

Published in Phys. Rev., v. 105: 1424-1426, Mar. 1, 1957.

The general energy equation of a viscous, heat-conducting and electrical-conducting fluid in magneto-gas dynamics has been derived. Various simplified forms of energy equations have been discussed, particularly for the cases with magneto-gas dynamic approximations. The fundamental equations of magneto-gas dynamics are also given. (Contractor's abstract)

MDU.11:024

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

CHARACTERISTICS AND SOUND SPEED IN NON-ISENTROPIC GAS FLOWS WITH NONEQUILIBRIUM THERMODYNAMIC STATES, by E. L. Resler, Jr. [1957] 6p. illus. (AF 18(600)993) Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 785-790, Nov. 1957.

A theory is developed extending the method of characteristics to flow problems involving large heat capacities and/or finite chemical reaction rates. Special cases, appropriate to present high-speed flow problems, are considered in more detail, e.g., heat-capacity lag and dissociation of a gas made up of diatomic molecules. The theory is easily adaptable to the usual finite-wave approximation used for computations. (Contractor's abstract)

MDU.11:025

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE EFFECT OF MOLECULAR VIBRATION ON RECOVERY TEMPERATURE IN PLANE COUETTE

FLOW, by H.-T. Yang. May 9, 1957, 12p. incl. diagr. (AF 18(600)993) Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 911-912, Dec. 1957.

A study has been made of the effect of molecular vibration on the recovery temperature in plane Couette flow at a temperature range between 600° and 3060°K. The plane Couette flow consists of the fluid flow between two infinite, parallel plates at a distance δ apart with the lower plate stationary at a temperature T_w and the upper plate moving with a velocity U in its own plane at a temperature T^* . It is assumed that sufficient time (larger than relaxation time), has elapsed since the start of motion of the upper plate so that the inert degrees of freedom are already in equilibrium; therefore the only independent variable is the ordinate y normal to the plates. The continuity equation and the boundary conditions on both plates require the normal component of flow velocity to vanish, i.e., $v = 0$. It is assumed further that the flow may be considered as continuum. The recovery temperatures, with molecular vibration taken into consideration, are presented gradually for oxygen and nitrogen at Pr (Prandtl number) = 0.70 and $T_w = 300^\circ K$. It is seen that the decrease of recovery temperature owing to absorption of internal energy by the molecular vibration is quite appreciable.

MDU.11:026

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

CYLINDRICAL SHOCK WAVES PRODUCED BY INSTANTANEOUS ENERGY RELEASE IN MAGNETOGAS DYNAMICS, by S. I. Pai. Feb. 1958 [27]p. incl. diagrs. tables. (Technical note no. BN-120) (AFOSR-TN-58-215) (AF 18(600)993) AD 154116; PB 147454 Unclassified

Analysis has been made of the behavior of a cylindrical shock wave produced by instantaneous energy release along a straight line of infinite extent in a conducting gas subjected to a magnetic field with circular lines of force. Initially the gas is at rest and has constant temperature. Both the initial density and the initial magnetic field H_0 are assumed to be inversely proportional to some power of the radial distance r . It was found that similar solutions exist only if H_0 is proportional to $1/r$.

Similar solutions for various initial density distributions have been obtained. Numerical examples are given for constant initial density. The magnetic field has great influence on the pressure distribution but little influence on the density distribution within the shock. The pressure near the shock front is increased by the magnetic field while that near the center of the region is decreased. In

MDU. 11:027-030; MDU. 12:006, 007

general, the magnetic field increases the flow velocity within the cylindrical shock. (Contractor's abstract)

MDU.11:027

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SELECTED TOPICS FROM THE THEORY OF GAS FLOW AT HIGH TEMPERATURES (V). THE APPLICATION OF TRANSFER EQUATIONS TO THE CALCULATION OF DIFFUSION, HEAT CONDUCTION, VISCOSITY AND ELECTRIC CONDUCTIVITY. INTRODUCTION AND PART I, by J. M. Burgers. May 1958, 60p. incl. diagrs. (Technical note no. BN-124a) (AFOSR-TN-58-427) (AF 18(600)993) AD 158230
Unclassified

The equations of transfer are deduced from the Maxwell-Boltzmann equation, in the form in which this is known for binary collisions. The results have been given in a form with all terms complete, including those depending upon electric and magnetic forces. (Contractor's abstract, modified) (See item no. MDU.11:019 for Part IV)

MDU.11:028

[Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park].

SELECTED TOPICS FROM THE THEORY OF GAS FLOW AT HIGH TEMPERATURES (V). THE APPLICATION OF TRANSFER EQUATIONS TO THE CALCULATION OF DIFFUSION, HEAT CONDUCTION, VISCOSITY AND ELECTRIC CONDUCTIVITY, PART II, by J. M. Burgers. May 1958 [65]p. incl. tables. (Technical note BN-124b) (AFOSR-TN-58-427a) (AF 18(600)993) AD 200051
Unclassified

This section deals with specific applications of transfer equations. The topics treated are: (1) coefficients of diffusion, heat conduction and viscosity, (2) diffusion and heat conduction in a binary mixture, (3) collision cross sections, (4) cross sections for molecules repelling each other according to a potential function $E(r)$, (5) Coulomb forces, (6) electric conductivity in fully ionized and in partially ionized gases, (7) magnetic field influences upon viscosity, (8) temperature exchange between various molecules, and (9) cases with very strong magnetic fields.

MDU.11:029

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

PHENOMENA SURROUNDING HIGH SPEED FLIGHT, by J. M. Burgers. Final rept. Aug. 1958 [9]p. incl.

refs. (AFOSR-TR-58-115) (AF 18(600)993)
AD 202116; PB 143232

Unclassified

This report gives a brief summary about the following subjects: (1) Selected Topics from Theory of Gas Flow at High Temperatures; (2) Properties of Gases at High Temperature; Relaxation, Dissociation and Ionization; (3) Electro- and Magnetogasdynamics; (4) Hypersonic Boundary Layer Flow; (5) Jet Mixing and Flow with Heat Release; and (6) Dynamics of Rarefied Gases. A bibliography of technical notes and journal publications produced during this contract is included.

MDU.11:030

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

REDUCTION OF IKENBERRY-TRUEDELL EQUATIONS TO BURNETT EQUATIONS IN SLIP FLOW, by H.-T. Yang. [1958] [2]p. (AF 18(600)993) Unclassified

Published in Jour. Aeronaut. Sciences, v. 25: 404-405, June 1958.

The purpose of this note is to establish the exact equivalence of the second iterates of the Ikenberry-TrueDELL equations with the Burnett equations for slip flow.

MDU.12:006

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

FURTHER INVESTIGATIONS ON THE TRIANGULAR-PATCH STIMULATOR, by J. C. Hegarty and F. R. Hama. June 1957, 10p. incl. illus. diagrs. (Technical note no. BN-107) (AFOSR-TN-57-616) (AF 18(600)1014) AD 136605
Unclassified

Systematic investigations were made of the triangular patch turbulence stimulator which was proved to be very efficient. Results show that variations in shape and size of the plan form of the triangles do not affect the transition Reynolds number appreciably. The effectiveness, however, is rather sensitive to the flow direction to the stimulator. (Contractor's abstract)

MDU.12:007

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

REDUCTION OF SUPERSONIC JET NOISE BY MEANS OF TRIANGULAR-PATCH STIMULATOR, by F. R. Hama. Informal rept. Feb. 8, 1957 [5]p. incl. diagrs. [AF 18(600)1014] Unclassified

Small-scale tests were conducted with and without the

MDU.12:008 - MDU.12:011

triangular-patch stimulator, and the results were plotted to show total pressure in lb/sq in. vs sound level in db. Without the stimulator, it is shown that the noise level increases as the total pressure increases and a hump appears on the noise-level curve. In this hump region, screeching noise results. With the stimulator, the noise level increases when the total pressure is not very high, because the nozzle is overexpanded and the stimulator is not quite effective; however, the hump is eliminated completely and as a result the screeching noise is suppressed entirely. At higher total pressures, the noise level plateaus-off, i.e., the effectiveness of the stimulator increases as the total pressure increases.

MDU.12:008

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

REDUCTION OF UNDESIRABLE SHOCK-WAVE EFFECTS BY MEANS OF TRIANGULAR-PATCH STIMULATOR, by F. R. Hama. Informal rept. Mar. 6, 1957 [6]p. incl. illus. diagr. [AF18(600)1014]

Unclassified

An attempt was made to determine if an integral interference device, e.g., a triangular-patch stimulator, could be utilized to reduce shock waves, which are otherwise 2-dimensional (or conical), by shifting the direction of the oncoming flow to give weaker 3-dimensional configurations. In a simple experiment, a test was conducted in a straight diverging nozzle in which a thin brass stimulator, 1/32 in. thick, was attached on both the top and bottom sides of the nozzle. The results of this preliminary test indicate that the triangular-patch stimulator tends to reduce shock wave effects. It is suggested that stimulators of this type might find applications in: (1) preventing shock-induced separation; (2) reducing wave drag of a supersonic body; (3) improving the efficiency of a supersonic diffuser; (4) reducing boattail drag resulting from the jet effect; and (5) replacing the adjustable throat in an afterburner.

MDU.12:009

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NOTE ON THE BOUNDARY-LAYER INSTABILITY ON A FLAT PLATE STOPPED SUDDENLY, by F. R. Hama. Mar. 15, 1957, 1p. (AF 18(600)1014) Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 471, June 1957.

It is theorized that in shear flow, a 2-dimensional vortex line with a positive vorticity, i.e., having the same direction as the background vorticity, is unstable under 3-dimensional disturbances, whereas that with a negative vorticity is stable. Examination of the validity of

the second part of this theorem is the objective of this study, with special emphasis being focussed on the stability problem on a decelerated flat plate. First, the case when a smooth plate moving at a constant speed through a still fluid comes to a sudden stop is considered briefly. Then the case when the plate encounters a sudden stop, followed by a sudden start is studied. Experimental results indicate that the second part of the theorem is correct. Therefore, when a flat plate experiences deceleration and acceleration, the boundary layer is unstable in the deceleration stage, but the instability is harmless and will not result in transition. It is noted that if the plate is kept still for a long time after the sudden stop the 3-dimensional waviness is sufficiently intensified so that the stabilizing effect of the shear flow on a negative vortex will become no longer applicable. In addition, the succeeding acceleration even promotes a sudden appearance of a turbulent spot by stretching the 3-dimensional vortex loop, even though the vorticity of the loop is negative. It is pointed out that the present case, in which a plate itself is decelerated and accelerated, should be distinguished from the case when the vorticity of oncoming flow to the plate fluctuates so as to create pressure gradients in the stream direction. In the latter instance, the boundary layer may separate and produce dangerous positive discrete vortices, whereas the flow does not separate on an oscillating plate.

MDU.12:010

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

PROBABILITY DENSITY MEASUREMENTS USING ELECTRONIC PULSE COUNTING AND OPTICAL VOLTAGE DISCRIMINATION, by A. Miller. 1957, 27p. incl. diagrs. [AF 18(600)1014] Unclassified

A probability density measuring system, utilizing standard laboratory test instruments, optical voltage discrimination and electronic counting techniques, is presented. Experimental results are compared to theoretical curves to demonstrate the reliability of the system. (Contractor's abstract)

MDU.12:011

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THICK AXISYMMETRIC LAMINAR BOUNDARY LAYERS, by F. R. Hama. [1957] 12p. incl. refs. (AF 18(600)1014) Unclassified

Theories of thick axisymmetric laminar boundary layers along a thin circular cylinder are first reviewed briefly. The Mark-Glauert-Lighthill-Pohlhausen method is described in detail as it appears most attractive to practical purposes. In order to study experimentally the effect of large transverse curvature on boundary-layer

MDU.12:012 - MDU.12:015

problems, avoiding technical difficulties inherent to wind-tunnel experiments on such problems, the free-convection temperature field along a vertically-suspended thin cylinder is investigated. Experimental results are in excellent agreement with a theory developed analogous to the Mark-Glauert-Lighthill-Pohlhausen solution. Transition location is found far behind that in the two-dimensional case. (Contractor's abstract)

MDU.12:012

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE AXISYMMETRIC FREE-CONVECTION TEMPERATURE FIELD ALONG A VERTICAL THIN CYLINDER, by F. R. Hama and J. V. Recasso. Jan. 1958, 35p. diagrs. tables, refs. (Technical note no. BN-118) (AFOSR-TN-58-25) (AF 18(600)1014) AD 148064
Unclassified

The axisymmetric free-convection problem along a vertical thin cylinder is investigated theoretically as well as experimentally with a view to studying the effect of strong transverse curvature on boundary-layer problems. A theory is developed as an extension of the Glauert-Lighthill-Pohlhausen solution for any value of the x-parameter. Temperature profiles are measured at several sections along an electrically-heated brass cylinder of 10 ft height and 1/4 in. diameter. Experimental results of the local-heat-transfer coefficient agree well with the theory. This, in turn, justifies the theories of laminar boundary layer along a thin cylinder developed by Glauert and Lighthill and by others, at least indirectly. The location of laminar-turbulent transition is estimated from the temperature profiles and by a hot-wire observation. Transition is found to be delayed considerably compared with that in the two-dimensional case.

MDU.12:013

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A CORRELATION ANALYZER, by A. Haberstich and F. R. Hama. Mar. 1958, 1v. incl. illus. diagrs. (Technical note no. BN-125) (AFOSR-TN-58-338) (AF 18(600)1014) AD 154242; PB 133994
Unclassified

A detailed description is given of a correlation analyzer which measures the spectral equivalent of a double (time) correlation between any two signals. Actual measurements are made with a few artificial signals in order to determine its reliability. Although it is primarily designed for the direct measurement of the energy transfer function in the spectrum of turbulence, the instrument is considered capable of measuring the transfer function of any "black box." Therefore, it may

find versatile applications in buffeting, aerodynamic stability, and aeroelasticity as well as in electronics and servomechanisms. (Contractor's abstract)

MDU.12:014

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

EXPERIMENT ON THE AXISYMMETRIC FREE-CONVECTION FIELD ALONG A VERTICALLY-SUSPENDED WIRE, by F. R. Hama and J. Christiaens. May 1958, 15p. illus. diagrs. tables, refs. (Technical note no. BN-138) (AFOSR-TN-58-444) (AF 18(600)1014) AD 158249; PB 134714
Unclassified

In order to extend previous investigations on thick axisymmetric free-convection field to a higher range of the x-parameter, the temperature profile along an electrically heated vertical wire of 0.02 in. diam and 5 ft length is measured by use of an interferometer. Experimental results are again in good agreement with the theory. (Contractor's abstract)

MDU.12:015

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

INVESTIGATION OF TRANSITION CAUSED BY THE STOPPING OF A FLAT PLATE, by J. C. Hegarty. June 1958 [33]p. incl. illus. diagrs. (Technical note no. BN-141) (AFOSR-TN-58-627) (AF 18(600)1014) AD 182157; PB 138871
Unclassified

The present paper investigates the amplification of the small perturbation due to boundary-layer instability into discrete vortex lines and their subsequent distortion into a three-dimensional pattern. The intensification of the vortices and the three-dimensional distortion is believed to be a necessary step of the phenomena of transition from laminar to turbulent flow. The investigation was initiated because of criticism against the use of a trip wire as a means of promoting the process of amplification of the small perturbation. The results in many respects are in accord with those obtained from the trip wire. In addition to the study of the three-dimensionality present in the vortex line, the mechanics of the rotation of the distorted line is also discussed. The rotation is due to the interaction of the mean flow with the induction effect. Relations between the parameters $\alpha \delta^*$, c_r and R_δ are plotted at the rear, R_δ being

limited to a small range of values. (Contractor's abstract)

MDU.13:007 - MDU. 13:010

MDU.13:007

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE APPLICATION OF THE THEORY OF STOCHASTIC PROCESSES TO CHEMICAL KINETICS, by E. W. Montroll and K. E. Shuler. Feb. 1957, 1v. incl. diagre. table, refs. (Technical note no. BN-94) (AFOSR-TN-57-73) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1315 and Atomic Energy Commission) AD 120418 Unclassified

Also published in Advances in Chem. Phys., v. 1: 361-399, 1958.

This is a review of the theory of the conditions for validity of the use of equilibrium theories in the analysis of chemical kinetics. The work of Hinshelwood, Prigogine, Kramers, Eyring, and others is discussed. A truncated harmonic oscillator model is presented and analyzed in great detail. Conditions are found under which equilibrium theory is appropriate, as well as those under which equilibrium rates are either too slow or too fast. A general theory of reaction kinetics as a stochastic first passage time problem is developed. (Contractor's abstract)

MDU.13:008

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A PHENOMENOLOGICAL THEORY OF BREAKDOWN PROCESSES, by G. H. Weiss. May 1957, 7p. (Technical note no. BN-98) (AFOSR-TN-57-226) (AF 18(600)1315) AD 126524 Unclassified

A phenomenological theory of mechanical breakdown phenomena is presented in the form of a "pure death" stochastic process. It includes as a special case, a theory recently proposed by Coleman, but the method of analysis can be used for more general studies of breakdown phenomena. (Contractor's abstract)

MDU.13:009

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

EFFECT OF DEFECTS ON SPIN INTERACTIONS IN A SIMPLE CUBIC LATTICE, by A. Ishihara. May 1957, 36p. (Technical note no. BN-97) (AFOSR-TN-57-263) (AF 18(600)1315) AD 126562 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 239, Apr. 25, 1957.

Also published in Phys. Rev., v. 108: 619-629, Nov. 1, 1957.

Effects of lattice defects such as foreign atoms or holes on spin-spin interactions in a simple cubic lattice are calculated by using the so-called spherical model developed by Montroll, Berlin and Kac, and others. In the case when the concentration of defects is low and the distance between any pair of defects is large, the exact positions of defects are not important and the excess free energy and other thermodynamical functions are determined by the concentration and the nature of defects. The Langevin - Curie law of magnetic susceptibility is modified because of the presence of defects. The ferromagnetic Curie point is also determined by defects and it is a linear function of defects when the concentration is not large. In the case when defect atoms have stronger exchange interactions with their neighbors than the rest of nearest neighbors, the Curie point is raised and the specific heat vs temperature curve is enhanced. The reverse is true when defect atoms have weaker exchange interactions. (Contractor's abstract)

MDU.13:010

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE MEAN FIRST PASSAGE TIME FOR A RANDOM WALKER AND ITS APPLICATION TO CHEMICAL KINETICS, by S. K. Kim. June 1957, 31p. (Technical note no. BN-100) (AFOSR-TN-57-326) (AF 18(600)1315) AD 132398 Unclassified

Also published in Jour. Chem. Phys., v. 28: 1057-1067, June 1958.

The mean first passage time for a random walk with reflecting and absorbing barriers is computed by assuming Onsager's reciprocal relation for the transition probabilities. The result, which is valid for an arbitrary dimensional random walk, appears as a quotient of determinants whose elements are the transition probabilities and the initial distribution. For the one dimensional case, this result is written as a series which converges rapidly when nearest neighbor transitions predominate; in fact, the series reduces to a closed form for the case when only nearest neighbor transitions are allowed, and always converges for the case when only nearest and next-nearest transitions are allowed. Montroll and Shuler's computation of the mean first passage time for the case of the truncated harmonic oscillator model of a diatomic molecule is simplified and extended to an arbitrary initial distribution. In addition, the mean first passage time for the case of anharmonic oscillator model is computed by using the transition probability obtained by Shuler, Bazley and Montroll. In terms of the mean first passage time, the range of validity of the equilibrium theory in chemical kinetics is discussed. (Contractor's abstract)

MDU.13:011

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

DEFECTS ON A DIPOLE LATTICE, by A. Isihara. June 1957, 17p. (Technical rept. no. 76) (AFOSR-TN-57-387) (AF 18(600)1315) AD 132462 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1956.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 42, Jan. 29, 1958.

Also published in Jour. Chem. Phys., v. 27: 1174-1179, Nov. 1957.

Effects of defects on dipole interactions in a simple cubic lattice are calculated using the spherical model developed by Berlin and Thomsen, Lax, and others. When the concentration of defects is small, thermodynamical functions are linearly dependent on the concentration. The Curie temperature in the three-dimensional lattice is raised or lowered linearly with the concentration according to whether the defects have stronger or weaker dipole interactions with their neighbors than the interactions which the rest of atoms have. Lattice vacancies also reduce the Curie temperature. The specific heat and electric susceptibility of defect lattice are calculated. In the presence of an homogeneous electric field, there exists a critical field which is influenced by defects. (Contractor's abstract)

MDU.13:012

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

Tensor Formalism for Coulomb Interactions and Asymptotic Properties of Multipole Expansions, by L. Jansen. Oct. 1957, 38p. incl. tables. (Technical note no. BN-113) (AFOSR-TN-57-698) (AF 18(600)1315) AD 136691 Unclassified

Also published in Phys. Rev., v. 110: 661-669, May 1, 1958.

A tensor notation for electric multipole interactions between molecular charge distributions is developed and applied to the evaluation of first and second order interaction energies. An equivalence theorem between cylindrically symmetric and linear assemblies of charge is established. The mathematical implications of using a multipole Taylor expansion in regions of configuration space where the series has no validity is discussed for the first and second orders of perturbation theory. (Contractor's abstract)

MDU.13:013

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A STUDY OF THE RESTRICTED RANDOM WALK, by R. S. Lehman and G. H. Weiss. Nov. 1957, 23p. incl. tables, refs. (Technical note no. BN-115) (AFOSR-TN-57-735) (AF 18(600)1315) AD 136722 Unclassified

Also published in Jour. Soc. Indust. Appl. Math., v. 6: 257-278, Sept. 1956.

This paper treats several aspects of the restricted random walk, both theoretically and numerically. It presents, for the first time, a study of the phenomenon of "trapping" in such random walks. A proof is given that such trapping must occur with probability one in most lattices. An ORDVAC study of this phenomenon shows that the number of survivors is very nearly an exponentially decreasing function of the number of steps. A further ORDVAC study of the mean square end-to-end distance of the restricted random walk is made, but sampling difficulties prevent definitive conclusions from being drawn. (Contractor's abstract)

MDU.13:014

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

REMARKS ON THE VIBRATIONS OF DIATOMIC LATTICES, by A. A. Maradudin, P. Mazur and others. [1958] [22]p. incl. diagrs. table, refs. (Technical note no. BN-114) (AFOSR-TN-57-737) (AF 18(600)1315) AD 136723 Unclassified

Also published in Rev. Modern Phys., v. 30: 175-196, Jan. 1958.

This is mainly a review of selected topics in the theory of crystal vibrations, restricted primarily to aspects which the authors themselves have helped develop. The first section contains an interesting review of the history of the analysis of vibration spectra, beginning with related work of Lord Kelvin and Lord Rayleigh and ending with recent attempts to analyze singularities. This is followed by a derivation of the exact spectrum for an ordered diatomic cubic lattice with nearest neighbor forces only. The largest part of the paper, however, deals with various methods for approximating the spectrum of disordered binary alloys forming a cubic lattice and includes a discussion of (1) dilute mixtures, (2) slightly disordered structures, and (3) completely disordered arrangements. (Math. Rev. abstract)

MDU.13:015 - MDU.13:018

MDU.13:015

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

INTERMOLECULAR POTENTIAL BETWEEN LARGE MOLECULES, by A. Ishihara and R. Koyama. [1957] [8]p. incl. diagrs. table, refs. [AF 18(600)1315]

Unclassified

Published in Jour. Phys. Soc. Japan, v. 12: 32-39, Jan. 1957.

The intermolecular potential between spherical polyatomic molecules is calculated, assuming the Lennard-Jones potential between atoms of polyatomic molecules. Owing to the distribution of atoms in polyatomic molecules the degree of infinite of potential is lowered when two polyatomic molecules approach each other. In the case of uniform distribution of atoms in polyatomic molecules, the degree is lowered by 5 orders and the minimum value of the potential is proportional to the radius of polyatomic molecule and to the square of the density of the atoms. At large intermolecular distance, the result of calculation of this case coincides with the results of Atoji and Lipscomb and of Hamaker. Calculation for a parabolic distribution of atoms is also given. The temperature and molecular weight dependence of the second virial coefficient of high polymer solutions are explained with the aid of calculated potential function.

MDU.13:016

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE RELAXATION EFFECTS IN MIXED STRONG ELECTROLYTES, by L. Onsager and S. K. Kim. [1957] [15]p. incl. diagrs. tables, refs. (In cooperation with Yale U. Sterling Chemistry Lab., New Haven, Conn.) [AF 18(600)1315]

Unclassified

Published in Jour. Phys. Chem., v. 61: 215-229, Feb. 1957.

The separation of the Onsager-Fuoss equations for the modification of interionic forces by conduction, diffusion and viscosity in mixed electrolytes is greatly facilitated with the aid of an algebraic device which was invented more recently. The numerical work involved in applying the theory to mixtures is substantially reduced. While further refinement of theory has not been undertaken, helpful intermediate results have been obtained. (Contractor's abstract)

MDU.13:017

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

WIEN EFFECT IN SIMPLE STRONG ELECTROLYTES, by L. Onsager and S. K. Kim. [1957] [18]p. incl. diagrs. refs. (In cooperation with Yale U. Sterling Chemistry Lab., New Haven, Conn.) [AF 18(600)1315]

Unclassified

Published in Jour. Phys. Chem., v. 61: 198-215, Feb. 1957.

Wilson's computation of the Wien effect in strong binary electrolytes is simplified and extended to simple electrolytes of all valence types. The results appear as double integrals, which are reduced to closed form by elliptic substitutions. Alternative forms for evaluation by descending power series (for high field intensities) or by numerical quadrature (best for low field intensities) are described in detail. (Contractor's abstract)

MDU.13:018

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

STUDIES IN NON-EQUILIBRIUM RATE PROCESSES. III. THE VIBRATIONAL RELAXATION OF A SYSTEM OF ANHARMONIC OSCILLATIONS, by N. W. Bazley, E. W. Montroll and others. Jan. 1958 [15]p. incl. diagrs. (Technical note BN-118) (AFOSR-TN-58-84) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1315, Office of Naval Research, and Atomic Energy Commission) AD 148133

Unclassified

Also published in Jour. Chem. Phys., v. 28: 700-705, Apr. 1958.

The previous work on vibrational relaxation of a system of harmonic oscillators has been extended to a system of anharmonic (Morse) oscillators. Numerical solutions of the relevant relaxation equations have been obtained on the ILLIAC (University of Illinois electronic digital computer) for some particular cases of initial δ -function and Boltzmann distributions. The results of these calculations show that the deviations of the fractional level population from the harmonic oscillator values are very small, being of the order of the anharmonicity in the case of relaxation of the initial Boltzmann distribution, and about five times the anharmonicity for the relaxation of the δ -function distribution. A general analytical perturbation procedure for the solution of the relaxation equations has been outlined and analytical solutions for several special cases are discussed briefly.

MDU.13:019 - MDU.13:022

MDU.13:019

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

FREE RADICAL STATISTICS, by J. L. Jackson and E. W. Montroll. Feb. 1958, 1v. incl. diagrs. tables. (Technical note no. BN-121) (In cooperation with National Bureau of Standards, Washington, D. C.) (AFOSR-TN-58-186) (AF 18(600)1315) AD 152219 Unclassified

Also published in Jour. Chem. Phys., v. 28: 1101-1109, June 1958.

On the basis of a simplified statistical model, average concentrations of trapped free radicals condensed from a gaseous mixture are calculated. The trapped free radical concentration is obtained as a function of the free radical concentration in the gas and of the number of nearest neighbors in the solid. The mathematical problem presented by the model is solved rigorously in the one dimensional case (two nearest neighbors) and approximately for arbitrary numbers of nearest neighbors. Typical calculated percentages of trapped free radicals range from 14% for a simple cubic lattice to 10% for a face-centered cubic lattice, when the solid is condensed from a completely dissociated gaseous mixture. (Contractor's abstract)

eralized for the zero-point energy of a one-dimensional lattice and higher-order terms are obtained in the expansion. In two dimensions the agreement between the more accurate calculation here and that of Prigogine et al., indicates that their use of the Debye frequency spectrum as a zeroth approximation does not lead to appreciable error. In addition to a calculation of additive functions of the normal mode frequencies, a discussion is presented of the low-frequency end of the frequency-distribution function. (Contractor's abstract)

MDU.13:021

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A METHOD FOR EVALUATING INTERACTION INTEGRALS, by A. [A.] Maradudin and G. [H.] Weiss. Feb. 1958 [2]p. (Technical note no. BN-126) (AFOSR-TN-58-278) (AF 18(600)1315 and AF 18(600)1015) AD 154180 Unclassified

Also published in Amer. Jour. Phys., v. 26: 499-500, Oct. 1958.

Fourier transform methods are suggested for the evaluation of multiple integrals which arise in electro-statics and quantum mechanics. The Fourier transform method reduces the interaction integral immediately from a sixfold to a threefold integral. The potential due to two Gaussian charge clouds, one of which is displaced, is calculated as an example of the method.

MDU.13:020

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THERMODYNAMIC PROPERTIES OF A DISORDERED LATTICE, by G. [H.] Weiss and A. [A.] Maradudin. Mar. 1958 [18]p. incl. diagrs. refs. (Technical note no. BN-127) (AFOSR-TN-58-277) (AF 18(600)1315 and AF 18(600)1015) AD 154179 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 233, May 1, 1958.

Also published in Jour. Phys. Chem. Solids, v. 7: 327-344, Dec. 1958.

A new method is presented for evaluating additive functions of the normal mode frequencies of disordered isotropic lattices as a perturbation-type expansion. The method is constructive; a recipe is given for writing down the general term of the expansion. The expression for the general term depends only on the evaluation of certain sums and integrals. A further advantage of the present method is that a discussion of the convergence of the resulting series solution is possible. This is generally difficult, if not impossible, in the case of the usual perturbation expansions. The result of Prigogine et al. (Physica, v. 20: 383, 1954) is rederived and gen-

MDU.13:022

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE DISORDERED LATTICE PROBLEM: A REVIEW, by A. A. Maradudin and G. H. Weiss. Apr. 1958 [26]p. incl. diagrs. refs. (Technical note no. BN-132) (AFOSR-TN-58-372) (AF 18(600)1315 and AF 18(600)-1015) AD 154278; PB 135362 Unclassified

Also published in Jour. Soc. Indust. Appl. Math., v. 6: 302-319, Sept. 1958.

A review was made of the disordered lattice problem which arises in the study of thermodynamic properties of binary alloys. The first work on this problem was done by Dyson (Phys. Rev., v. 92: 1331, 1953) who reduced the one dimensional problem to the solution of a non-linear integral equation. Further investigations were made of the one-dimensional problem, but no substantial progress has been reported to date. Other approximate procedures based on perturbation theory are discussed. (Contractor's abstract)

MDU.13:023 - MDU.13:027

MDU.13:023

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

VIBRATIONS OF A GENERALIZED DIATOMIC LATTICE, by A. A. Maradudin and G. H. Weiss. June 1958 [10]p. incl. diagrs. refs. (Technical note no. BN-140) (AFOSR-TN-58-507) (AF 18(600)1315 and AF 18(600)-1015) AD 158318 Unclassified

Also published in Jour. Chem. Phys., v. 29: 631-634, Sept. 1958.

The vibrational frequency spectra of diatomic linear lattices which are more general than the diatomic lattice treated by Kelvin, and more recently by Montroll, Mazur and Potts are studied. For example, using methods introduced by Asahi and Hori and, Mazur and Hoffman, the properties of a chain with the configuration AABAAB..., were studied. Some general results are given for the long wave length behavior of the frequency spectrum for periodic and disordered linear lattices.

MDU.13:024

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SOME REMARKS ABOUT FREQUENCY SPECTRUM OF CRYSTAL LATTICES, by J. Peretti. Aug. 1958, 35p. incl. refs. (Technical note no. BN-145) (AFOSR-TN-58-775) (AF 18(600)1315) AD 201921 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 12: 216-232, Feb. 1960.

A general method is given for the calculation of the frequency distribution of a crystal lattice in terms of the known atomic force constants. This formalism is used to calculate the frequency spectrum for special lattices, to investigate the singularities of the spectrum, and to derive the low temperature expansion of the spectrum. The analytical nature of the spectrum of a one-dimensional lattice has been investigated.

MDU.13:025

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A METHOD FOR EVALUATING CERTAIN LATTICE SUMS, by A. A. Maradudin and G. H. Weiss. Sept. 1958, 6p. incl. tables. (Technical note no. BN-148) (AFOSR-TN-58-927) (AF 18(600)1315 and AF 18(600)1015) AD 204737; PB 137776 Unclassified

Also published in Canad. Jour. Phys., v. 37: 170-173, Feb. 1959.

A rapidly convergent method for evaluating a certain class of lattice sums by the use of asymptotic series is presented. The method is illustrated by applying it to the evaluation of lattice sums previously studied by Benson and Schreiber.

MDU.13:026

[Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park].

SCREW DISLOCATION CORE STRUCTURES IN SODIUM CHLORIDE. I (Abstract), by A. A. Maradudin. [1958] [1]p. [AF 18(600)1315] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 233, May 1, 1958.

The positions of the ion rows at the core of a screw dislocation in sodium chloride have been calculated by minimizing semi-analytically the energy of interaction of these rows with themselves and the rest of the lattice. A Born-Mayer expression is used for the interionic potential function, and during the relaxation of the positions of the central ion rows all rows outside these are held fixed in the positions calculated by elastic theory. The numerical results indicate that this last restriction can lead to physically unrealistic results. Values for the relaxation displacements and energy changes will be presented.

MDU.13:027

[Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park].

THE SCREW DISLOCATION IN A HOOKEIAN LATTICE (Abstract), by A. A. Maradudin. [1958] [1]p. [AF 18(600)1315] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 233, May 1, 1958.

A simple model of a screw dislocation in a crystal lattice in which each atom interacts with its neighbors through Hooke's law forces is presented, and expressions for the displacement component and strain energy are obtained. Applications of the model to screw dislocations in alkali-halide crystals are discussed.

MDU.18:001 - MDU.18:004

MDU.18:001

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A NEW EXPERIMENTAL APPROACH TO THE ANALYSIS OF COMPRESSOR PERFORMANCE. APPLICATION OF THE BOMELBURG SPARK METHOD TO THE MEASUREMENT OF DIRECTIONAL VELOCITY TRAVERSES AT THE OUTLET OF AN IMPELLER, by J. Herzog. Jan. 1957, 9p. illus. diagrs. (Technical note no. BN-90) (AFOSR-TN-57-3) (AF 18(603)92) AD 115035 Unclassified

Transverse measurements were made of the direction and magnitude of the instantaneous absolute velocity extending across the blade channel at the outlet of a rotating aircraft supercharger impeller by means of a spark technique. The impeller was operated at open throttle condition. It was rotated at a speed greatly reduced below normal because of limitation of drive power. The measured data were analyzed and related to the design constants of the impeller. Results give an insight into the qualitative nature of the flow, and indicate that further experience is necessary to determine the attainable accuracy of the method.

MDU.18:002

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

CHARACTERISTICS OF THE TECHNIQUE OF AERODYNAMIC INVESTIGATION BY MEANS OF SERIES OF ELECTRIC SPARKS, by J. Herzog, J. R. Weske and others. July 1957 [66]p. incl. illus. diagrs. (Technical note no. BN-105) (AFOSR-TN-57-359) (AF 18(603)92; continuation of AF 18(600)893) AD 132432 Unclassified

The investigations of Bomelburg (See MDU.10:005) on the technique of generating series of electric sparks at high frequencies for use in aerodynamic investigations were supplemented to establish the characteristics of this method of measurement and to determine its accuracy and limits of applicability. Single electric sparks of widely varying energy were produced across a spark gap placed into a Schlieren bench. The motion of the air heated by the spark was studied by photographing the momentary Schlieren image produced by a flash of light triggered at brief systematically varied periods after the termination of the spark. A condenser was used to apply 30,000 v across a 1-cm spark gap. The duration of the spark was varied from 3.5 to 200 μ sec, and the time delay between the termination of the spark and the beginning of the light flash varied from 0 to 1000 μ sec. Results indicated that the body of hot gas produced by the spark retains its initial shape for about 30 μ sec but disintegration begins within 100 μ sec. Theory and experiment led to the conclusions that (1) the deviation of parabolic spark traces is less than 10% for spark traces,

the height of which does not exceed 30% of their base length, and (2) deviations for sinusoidal displacement curves are 25 times larger than for parabolas. The spark wake in colder air rose at a nearly constant rate (0.4 fps). At supersonic speeds the electric discharge tended to follow the shock waves. Theoretical relations are appended for the observed deviation of spark paths from curved displacement profiles of an air stream. These served as a basis for the experimental calibration in Poiseuille flow. The following appendices are attached: I. Analysis of the Deviation of Spark Paths from the Curved Displacement Profile of the Fluid; II. The Temperature Field of Two Instantaneous Semi-Infinite Straight Line Sources Joining at Right Angles in a Homogeneous Three-Dimensional Heat Conducting Medium; and III. On the Measurement of Wind (Tunnel) Velocity Distributions by the Electric Spark Method.

MDU.18:003

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

A NEW EXPERIMENTAL METHOD FOR THE INVESTIGATION OF FLOW IN TURBOMACHINES, by J. Herzog and J. R. Weske. [1957] 11p. illus. [AF 18(603)92] Unclassified

Presented at annual meeting of the Aeronaut. Research Organization (DVL) and Soc. for Aeronaut. Research (WGL), Essen (Germany), Apr. 9-12, 1957.

Presentation is made of an electric spark technique for the experimental investigation of instantaneous local conditions of flow, for which in present practice hot wire anemometry of piezoelectric pressure and similar techniques of measurements are applied. This technique, devised for general aerodynamic measurements by H. Bomelburg and adapted to the investigation of flow in turbomachines by J. Herzog makes use of series of high frequency electric sparks. It permits the visual observation and the measurement of magnitude and direction of local velocity vectors, averaged over a few μ sec, in non-steady three-dimensional fields of flow. The method should be useful especially in the investigation of steady or non-steady transonic flow past fixed or moving blade rows. Merits, as well as limitations, of the spark technique are discussed in connection with the presentation of results of tests. Possibilities of application to the solution of problems of research and development are illustrated by examples of measurements carried out on centrifugal and axial flow compressor rotors.

MDU.18:004

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

APPLICATION OF THE ELECTRIC SPARK METHOD TO THE INVESTIGATION OF TRANSONIC FLOW PAST

MDU.18:005; MDU.19:001-003

AIRFOILS AND AIRFOIL GRIDS, by J. R. Weske. Apr. 1958 [10]p. incl. illus. (Technical note no. BN-128) (AFOSR-TN-58-304) (AF 18(603)92) AD 154214

Unclassified

Experimental evidence is presented and analyzed in order to substantiate that the electric spark technique is an effective tool for the experimental study of phenomena of high speed and in particular for transonic flow. It is considered to be especially suitable for the investigation of three-dimensional and nonsteady characteristics of high speed flows. (Contractor's abstract, modified)

MDU.18:005

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THREE-DIMENSIONAL FLOW IN AXIAL TURBO-MACHINES, by J. R. Weske. Final rept. Apr. 1, 1958, 4p. (AFOSR-TR-58-53) (AF 18(603)92) AD 154244

Unclassified

Experimental work was carried out on rotating blade rows of both the axial flow and the radial flow type, and on fixed airfoil grids. The technique of electric sparks in the improved form developed by Bomelburg was used in order to cope with the three-dimensional and non-steady features of the flows encountered. To meet the requirements posed by the given task for qualitative survey as well as for quantitative measurements of the flow, the electric spark method was calibrated and adopted. It was shown that the accuracy of the electric spark method increases with air speed and that this method is especially suitable as a technique of measurement at transonic and supersonic speeds. Investigations of a rotating axial flow blade row were conducted with a rotating system of mirrors. Systematic measurements at the discharge of a rotating turbo-supercharger impeller were carried out. Further investigations with the electric spark technique were made in a suction wind tunnel of transonic flows past individual airfoils in grid arrangement.

MDU.19:001

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SONIC LIMIT SINGULARITIES. PART I. GENERAL THEORY, by G. S. S. Ludford and S. H. Schot. May 1958, 20p. incl. diagrs. (Technical note no. BN-134) (AFOSR-TN-58-398) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)154 and Office of Ordnance Research under DA 36-034-ord-1486) AD 154307

Unclassified

Also published in Arch. Rational Mech. Anal., v. 2: 160-172, 1958.

A new classification of limit singularities which may occur on the sonic line is given which is based on the vanishing of the stream functions Ψ_q and Ψ_g . The properties of the corresponding flows are investigated, and it is shown that every sonic limit singularity must lie on a sonic or a supersonic limit line.

MDU.19:002

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE STRUCTURE OF A HYDROMAGNETIC SHOCK IN STEADY PLANE MOTION, by G. S. S. Ludford. Apr. 1958 [26]p. incl. diagrs. (Technical note no. BN-131) (AFOSR-TN-58-418) (AF 49(638)154) AD 158221; PB 134620

Unclassified

Also published in Jour. Fluid Mech., v. 5: 67-80, Jan. 1959.

This paper considers the one dimensional transition solutions of the equations of steady plane wave motion of an electrically conducting perfect viscous gas in the presence of a magnetic field in its own plane, on the basis of classical continuum theory. (Contractor's abstract)

MDU.19:003

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SONIC LIMIT SINGULARITIES. PART II. EXAMPLES, by G. S. S. Ludford and S. H. Schot. May 1958 [30]p. incl. diagrs. (Technical note no. BN-135) (AFOSR-TN-58-419) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)154 and Office of Ordnance Research under DA 36-034-ord-1486) AD 158222

Unclassified

Also published in Arch. Rational Mech. Anal., v. 2: 173-190, 1958.

Previously developed theory (item no. MDU.19:001) is extended to an investigation of the case of a general separation constant $n \geq 0$ to show that the corresponding class of flows has certain well defined geometrical features. For n less than a certain value n_0 , a typical sonic limit line flow in the physical plane represents a compressible analog of the incompressible flow about a corner with a certain corner angle and must be envisaged as taking place on a quadruply sheeted surface. The sheets are joined at a supersonic limit line which has the shape of a portion of a hypocycloid ($n > 1$) or epicycloid ($n < 1$). For $n < 1$, portions of the same sheet overlap in the large. The shape of the sonic limit line is discussed when solutions corresponding to different n are superposed. In this case the supersonic limit line can be eliminated and an isolated sonic limit line is obtained.

MDU.19:004, 005; MDU.20:001-003

MDU.19:004

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SMALL PERTURBATIONS IN HYDROMAGNETICS, FREE OSCILLATIONS IN A RECTANGULAR BOX, AND THE PERFECTLY CONDUCTING GAS, by G. S. S. Ludford. July 1958, 24p. Incl. diagrs. (Technical rept. no. BN-143) (AFOSR-TN-58-700) (AF 49(638)154) AD 162234 Unclassified

This paper treats the small perturbations of an electrically conducting inviscid gas in the presence of a uniform undisturbed magnetic field. In particular the free oscillations in a rectangular box are determined and used to examine the limit of infinite conductivity. (Contractor's abstract)

MDU.19:005

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

RAYLEIGH'S PROBLEM IN HYDROMAGNETICS: IMPULSIVE MOTION OF A POLE-PIECE, by G. S. S. Ludford. Nov. 1958, 21p. (Technical note no. BN-151) (AFOSR-TN-58-1073) (AF 49(638)154) AD 207242 Unclassified

Also published in Arch. Rational Mech. Anal., v. 3: 14-27, 1959.

Consideration was given to the motion of an incompressible, viscous, electrically conducting fluid contained between the parallel, plane, pole-pieces $y = 0, h$, of a permanent magnet which provides a uniform external field in the y - direction. Starting at time $t = 0$, with fluid at rest, the magnet is made to move uniformly in the negative x - direction. (Contractor's abstract)

MDU.20:001

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON HIGHER ORDER BOUNDARY VALUE PROBLEMS FOR HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS IN TWO AND THREE VARIABLES, by A. K. Aziz. July 1958, 55p. refs. (Technical note no. BN-130) (AFOSR-TN-58-266) (AF 49(638)228) AD 158385; PB 135563 Unclassified

Also published in Jour. Math. and Mech., v. 10: 71-82, Jan. 1961.

The purpose of this paper is to consider certain boundary value problems of Ingersoll's type which may involve higher order partial derivatives in the boundary conditions, for the hyperbolic partial differential equations

$u_{xyz} + au_{xy} + bu_{xz} + cu_{yz} + du_x + eu_y + fu_z + gu = h(x, y, z)$ and $u_{xy} + au_x + bu_y + cu = f(x, y, u_x, u_y)$. (Contractor's abstract)

MDU.20:002

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE SOLUTION AND HUYGENS' PRINCIPLE FOR A SINGULAR CAUCHY PROBLEM, by D. W. Fox. July 1958, 37p. Incl. illus. (Technical note no. BN-137) (AFOSR-TN-58-568) (AF 49(638)228) AD 158387; PB 135570 Unclassified

Also published in Jour. Math. and Mech., v. 8: 197-219, Mar. 1959.

This paper gives an explicit solution in the large of the singular Cauchy problem for the hyperbolic equation

$U_{tt} + (k/t)U_t = \sum_{i=1}^n (U_{x_i x_i} + (\lambda_i/x_i^2)U)$ with the initial data $U(x, 0) = f(x)$ and $U_t(x, 0) = 0$, for all $i = 1, 2, \dots, n$.

The exact range of the parameter k for which the solution is given by an integral operator is determined. For all other non-exceptional values of k the solution is obtained by a recursive procedure which yields the analytic continuation of the integral in terms of k . The question of uniqueness is extensively treated. A main part of the investigation is devoted to the formulation of a necessary and sufficient criterion for Huygens' principle and the comparison of it to the corresponding results for the regular Cauchy problem and for the singular Cauchy problem for the Euler-Poisson-Darboux equation. (Contractor's abstract, modified)

MDU.20:003

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

ON THE GENERALIZED RADIATION PROBLEM OF WEINSTEIN, by J. L. Lions. Nov. 1958, 28p. (Technical note no. BN-149) (AFOSR-TN-58-1039) (AF 49(638)228) AD 206575 Unclassified

Also published in Jour. Math. and Mech., v. 8: 873-888, Nov. 1959.

The generalized radiation problem of Weinstein (item no. MDU.09:013) is to find a distribution $u(x, y)$ in the half plane $y \geq 0$ which satisfies $u_{xx} - u_{yy} - (k/y)u_y = 0$ with:

(1) $u(x, y) \rightarrow 0$ for $x \rightarrow y$, and (2) $u(x, 0) = F(x)$ where k is a complex number. Weinstein has proved the existence of a solution u for $-\infty < k < 1$ and for functions F that are smooth enough. The existence and uniqueness of u has now been extended to the case in which (1) $-\infty < \operatorname{Re} k < 1$ and without any condition on F , and (2) the most general

MDU.20:004; MDU.21:001, 002
MDU.15:002, 003

hypothesis on u is used. The impossibility of solving the problem for $Re\ k > 1$ has been demonstrated.

MDU.20:004

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE DIRICHLET PROBLEM FOR THE WAVE EQUATION, by D. W. Fox and C. Pucci. [1958] [28]p. incl. refs. (AF 49(638)228) Unclassified

Published in Ann. Mat. Pura Appl., v. 46: 155-182, 1958.

A vibrating string fixed at both ends is considered as an example of the Dirichlet problem for the wave equation. The problem is related to the study of a functional equation for which trigonometric solutions are given. The instability of the solutions to small changes in the boundary data is illustrated. The computation of the solution in the case of boundary data which are approximate is shown to be possible.

MDU.21:001

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE SECOND APPROXIMATION TO THE STRESS TENSOR AND THE HEAT FLUX VECTOR IN A GAS FOR KROOK'S FORM OF THE COLLISION EQUATION, by H.-T. Yang. July 1958, 10p. (Technical note no. BN-142) (AFOSR-TN-58-753) (AF 49(638)401) AD 201612 Unclassified

The present note supplements Chapter IV of "Selected Topics from the Theory of Gas Flow at High Temperatures" by J. M. Burgers. The second approximation to the heat flux vector in a gas is obtained. The second approximation to stress and heat flux based on Krook's equation are compared with those given by Ikenberry and Truesdell based on the complete Boltzmann equation for a Maxwellian gas.

MDU.21:002

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE MECHANISM OF THERMAL IONIZATION BEHIND STRONG SHOCK WAVES, by H. D. Weymann. July 1958 [40]p. incl. illus. diagrs. refs. (Technical note no. BN-144) (AFOSR-TN-58-788) (AF 49(638)-401) AD 203113 Unclassified

The ionization process behind shock waves in noble gases has been investigated. It was found that in the initial stage, ionization follows a two step process in which a given atom is raised to the first excited elec-

tronic state by collision with another atom. Ionization is achieved after a second collision with an atom having sufficient relative translational energy to complete the process. It was not necessary to postulate that impurities influence the ionization rate of the noble gas. The theoretically derived temperature and density dependence of the ionization relaxation time is in agreement with the experimental results obtained by a number of different methods. A comparison of the absolute values of the relaxation times obtained theoretically and experimentally permits an evaluation of the cross sections for excitation and ionization by atom-atom collisions. (Contractor's abstract)

MDU.15:002

Maryland U. Inst. of Molecular Physics, College Park.

MOLECULAR SCATTERING BY AN EXPONENTIAL POTENTIAL, by E. A. Mason. Feb. 1, 1957, 11p. incl. diagr. refs. (Rept. no. IMP-OSR-2) (AFOSR-TN-57-44) (AF 18(600)1562) AD 115082 Unclassified

A method is given for analyzing the results of small angle scattering measurements in terms of an intermolecular potential energy which can be represented as a decreasing exponential. A small angle approximation is used throughout, which permits the calculations to be performed analytically. As an example, the scattering of H_3^+ by He is considered, and the present method shown to be a considerable improvement over the previous interpretation in terms of an inverse power potential energy function. The same method can also be applied to other algebraic forms of potential energy functions. (Contractor's abstract)

MDU.15:003

Maryland U. Inst. of Molecular Physics, College Park.

CALCULATION OF SECOND VIRIAL AND JOULE-THOMSON COEFFICIENTS OF GASES AT VERY HIGH TEMPERATURES, by E. A. Mason. Feb. 18, 1957, 9p. incl. diagrs. (AFOSR-TN-57-81) (AF 18(600)1562) AD 120427 Unclassified

Also published in Indus. Engineering Chem., v. 50: 1033-1035, July 1958.

Formulas are given for the second virial coefficients and zero-pressure Joule-Thomson coefficients of a gas at a temperature high enough that all molecular encounters can be assumed to be controlled only by forces of repulsion. Two forms of molecular interaction energy are considered: inverse powers and exponentials. The results for the inverse power potential are not new, but are for the physically more realistic exponential, for which an asymptotic series is given of which just the first term is almost always sufficient. As an example, the second virial coefficient of helium is calculated at

MDU.15:004 - MDU.15:007

high temperatures from an exponential potential given by Amdur and Harkness, and based primarily on beam scattering experiments. The agreement with experiment is satisfactory. The asymptotic formula also enables a check to be made on a semi-empirical calculation scheme proposed by Hirschfelder and Eliason. The accuracy of the semi-empirical scheme is somewhat disappointing, and a modification is proposed.

MDU.15:004

Maryland U. Inst. of Molecular Physics, College Park.

INTERACTION ENERGIES AND SCATTERING CROSS SECTIONS OF HYDROGEN IONS IN HELIUM, by E. A. Mason and J. T. Vanderslice. Apr. 11, 1957, 40p. incl. diagrs. tables, refs. (AFOSR-TN-57-152) (AF 18(600)-1524) AD 126442 Unclassified

Also published in Jour. Chem. Phys., v. 27: 917-927, Oct. 1957.

The interaction energies for the $H^+ - He$ and $H_2^+ - He$ system have been calculated for a range of internuclear distances and, in the $H_2^+ - He$ case, for two different configurations. The results are used to analyze the ion-scattering measurements of Simons and co-workers. It has been found that the predicted scattering cross sections are in remarkable agreement with the measured ones, provided allowance is made for a finite width of the ion beam. This agreement implies that the method of interpreting measured cross sections in terms of molecular forces is correct, and that specific apparatus effects have been correctly analyzed. The present calculations suggest, in contrast to previous assumptions, that the important forces are ones of repulsion rather than attraction, with the exception of those cases where chemical binding is clearly involved. It also appears that to obtain precise force information of physical significance from such scattering measurements, it is necessary to make allowance for the finite width of the ion beam. This has been illustrated for the scattering of H_3^+ ions in helium. Finally, the cross-section equations have been integrated for the case of scattering by an exponential potential and by a Lennard-Jones (8-4) potential.

MDU.15:005

Maryland U. Inst. of Molecular Physics, College Park.

SCATTERING CROSS SECTIONS AND INTERACTION ENERGIES OF LOW-VELOCITY He^+ IONS IN HELIUM, by E. A. Mason and J. T. Vanderslice. July 10, 1957 [7]p. incl. diagrs. (AFOSR-TN-57-575) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1562 and National Advisory Committee for Aeronautics) AD 136563 Unclassified

Also published in Phys. Rev., v. 108: 293-294, Oct. 15, 1957.

It is pointed out that the determination of ion-molecule forces from results of measurements of scattering of low-velocity ion beams in gases can be seriously in error unless some a priori knowledge of the nature of the forces is available. The scattering of He^+ in He is chosen as an illustration. The elastic and charge exchange cross sections calculated from Moisewitschs' theoretical force laws are shown to be in good agreement with the experimental values of Cramer and Simons. The force law determined by the latter authors directly from their measurements is in error because of the assumption of an incorrect form and the failure to consider the two interaction states involved.

MDU.15:006

Maryland U. Inst. of Molecular Physics, College Park.

INTERACTION ENERGY AND SCATTERING CROSS SECTIONS OF H^- IONS IN HELIUM, by E. A. Mason and J. T. Vanderslice. Sept. 20, 1957, 17p. incl. diagrs. table, refs. (AFOSR-TN-57-793) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1562 and National Advisory Committee for Aeronautics) AD 148025 Unclassified

Also published in Jour. Chem. Phys., v. 28: 253-257, Feb. 1958.

An approximate quantum mechanical calculation is made of the energy of interaction of H^- and He. The results are not of high accuracy, but serve to indicate the general nature of the interaction. This knowledge makes it possible to calculate more accurate values of the interaction from measured elastic scattering cross sections. The resultant interaction is combined with the previously known interaction of H and He to give an approximation to the inelastic (electron detachment) cross section, which is shown to be in reasonable agreement with the experiment. The calculations emphasize the importance of the repulsion forces rather than the attraction forces. The accuracy of a correction for the finite width of the ion is also examined in some detail.

MDU.15:007

Maryland U. Inst. of Molecular Physics, College Park.

MOBILITY OF GASEOUS IONS IN WEAK ELECTRIC FIELDS, by E. A. Mason and H. W. Schamp, Jr. Feb. 13, 1956, 73p. incl. diagrs. tables, refs. (Rept. no. IMP-OSR-8) (AFOSR-TN-58-104) (AF 18(600)1562) AD 152013 Unclassified

Also published in Ann. Phys., v. 4: 233-270, July 1958.

Kihara's (Rev. Modern Phys., v. 25: 844, 1953) extension

MDU.15:008 - MDU.15:010

of the Chapman-Enskog theory of transport phenomena has been used (1) to obtain second- and third-order approximations to the mobility of gaseous ions in a weak electric field as a function of temperature and field strength and (2) to calculate the required collision integrals for a more realistic potential energy function than was used previously. This method assumed that there is no charge exchange between ions and molecules, no clustering occurs, and the quantum effects can be neglected. The mobility was expressed as a series in ascending powers of the square of the field strength with coefficients which were complicated functions of the temperature, the mass ratio of the ions and molecules, and the force law between the ions and molecules. The collision integrals were evaluated by numerical integration for a force law which considers the charge-induced dipole and quadrupole, the London dispersion forces, and an inverse twelfth power repulsion potential. In the potential energy function, 3 disposable parameters specified the depth and position of the minimum and the relative magnitudes of the various terms. Results of present calculations were used to analyze mobility data to obtain the disposable parameters which determined the ion-molecule force law. Good agreement existed between theory and experiment except for cases in which clustering was expected. (Contractor's abstract)

MDU.15:008

Maryland U. Inst. of Molecular Physics, College Park.

INTERACTION ENERGY AND MOBILITY OF Li^+ IONS IN HELIUM, by E. A. Mason, H. W. Schamp, Jr., and J. T. Vanderslice. Apr. 1, 1958 [16]p. incl. diagrs. table, refs. (Rept. no. IMP-OSR-9) (AFOSR-TN-58-271) (AF 18(600)1562) AD 154172 Unclassified

Also published in Phys. Rev., v. 112: 445-448, Oct. 15, 1958.

The interaction energy of Li^+ and He has been calculated for a range of internuclear separations. The results are not in very good agreement with a similar calculation by Meyerott (Phys. Rev., v. 66: 242, 1944), who used the same wave functions but approximated many of the molecular integrals. Considerable uncertainty is caused by lack of knowledge of the second-order exchange energy. The results are used to calculate the mobility of Li^+ ions in He gas as a function of temperature for comparison with experiment. It is concluded that the theoretical interaction energy is not inconsistent with the experimental mobility data, within the uncertainty caused by the second-order exchange energy. (Contractor's abstract)

MDU.15:009

Maryland U. Inst. of Molecular Physics, College Park.

PROPERTIES OF GASES AT EXTREMELY HIGH

TEMPERATURES, by I. Amdur and E. A. Mason. Aug. 1, 1958, 49p. incl. diagrs. tables, refs. (Rept. no. IMP-OSR-10) (AFOSR-TN-58-688) (In cooperation with Massachusetts Inst. of Tech., Dept. of Chemistry, Cambridge) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1562 and Office of Naval Research under Nonr-184123) AD 162222

Unclassified

Presented at Convention on Condensed States of Simple Systems, Varenna (Italy), Sept. 11-15, 1957.

Also published in Phys. Fluids, v. 1: 370-383, Sept.-Oct. 1958.

Known intermolecular force laws are used to calculate virial coefficients of the equation of state and the transport properties at very high temperatures for the rare gases and for molecular nitrogen. The crucial force laws which enable the calculations to be carried to high temperatures are those derived from molecular beam scattering measurements, which are valid at close distances of molecular approach. The calculations cover the temperature range from 1000° to $15,000^\circ\text{K}$, but take into account only the translational degrees of freedom and neglect the effects of excitation, dissociation, and ionization. The treatment of mixtures is outlined, and illustrated by calculations for the binary system helium-argon. The methods which are used offer an approach to the problem of obtaining reasonably accurate estimates of gas properties at temperatures so high that direct experiments would be extremely difficult, if not impossible. (Contractor's abstract)

MDU.15:010

Maryland U. Inst. of Molecular Physics, College Park.

MOBILITY OF HYDROGEN IONS (H^+ , H_2^+ , H_3^+) IN HYDROGEN, by E. A. Mason and J. T. Vanderslice. Nov. 14, 1958, 14p. diagrs. table, refs. (Rept. no. IMP-OSR-11) (AFOSR-TN-58-1005) (AF 18(600)1562) AD 206148 Unclassified

Also published in Phys. Rev., v. 114: 497-502, Apr. 15, 1959.

Force laws for H^+ , H_2^+ , and H_3^+ in H_2 have been calculated from theory and also from results on the scattering of low-velocity ion beams in H_2 gas. These results have been used to calculate the mobilities of the hydrogen ions in H_2 gas as a function of temperature. It has been found that the mobilities of H^+ and H_2^+ decrease slightly with increasing temperature, but the mobility of H_3^+ increases strongly. The agreement with experiment indicates that the unidentified hydrogen ion whose mobility has been measured is probably H_2^+ , rather than the usually assumed H_3^+ . (Contractor's abstract)

MDU. 15:011, MGH. 01:001;
MGH. 02:001

MDU.15:011

Maryland U. Inst. of Molecular Physics, College Park.

NOTE ON THE ABSORPTION OF RADIATION BY A
CYLINDRICAL SAMPLE OF A STRONG ABSORBER,
by E. A. Mason. [1958] [1]p. [AF 18(600)1562]

Unclassified

Published in Jour. Chem. Phys., v. 29: 1184, Nov. 1958.

The calculation of the absorption of radiation by a cylindrical sample of a strong absorber has been reduced by W. H. Clingman (Jour. Chem. Phys., v. 27: 322, 1957) to the evaluation of the integral,

$$J(\alpha) = (4/\pi\alpha) \int_0^{\pi/2} [1 - \exp(-\alpha \sin\theta)] \sin\theta \, d\theta,$$

where α is a dimensionless parameter involving the radius, density, and mass absorption coefficient of the sample. It is assumed that the incident light is parallel and that end effects are negligible. Clingman evaluated this integral by expanding the exponential in the integrand by the usual power series and integrating term by term. The very slow convergence for large α of the resulting series was overcome by the use of an IBM 650 calculator, and values of $J(\alpha)$ were tabulated up to $\alpha = 9.9$. It is possible to develop another series for $J(\alpha)$ which converges rapidly for large values of α , and which is useful for the evaluation of $J(\alpha)$ with a desk calculator. A further advantage of a simple series over a set of tables is that problems involving integrals of $J(\alpha)$ are more easily handled. Such problems arise, for instance, in connection with the Raman spectra of strongly absorbing substances. If the integration variable is changed to $x = \sin\theta$, the above equation can be written as

$$J(\alpha) = (4/\pi\alpha) \left[1 - \int_0^1 e^{-\alpha x} (1-x^2)^{-\frac{1}{2}} x \, dx \right].$$

The term $(1-x^2)^{-\frac{1}{2}}$ is expanded by the binomial theorem and the integration carried out term by term to give

$$J(\alpha) = (4/\pi\alpha) (1 - \alpha^{-2} - 3\alpha^{-4} \dots),$$

in which a number of exponentially decreasing terms have been dropped as negligible for large α . This simple formula is surprisingly accurate; for $\alpha = 4$, it is in error by only 0.14%, and the accuracy improves as α increases. The series is only asymptotically convergent, but the accuracy obtainable is obviously more than adequate.

MGH.01:001

Massachusetts General Hospital. Dept. of Neurosurgery,
Boston.ALTERATIONS OF CENTRAL NERVOUS SYSTEM
FUNCTION BY FOCUSED ULTRASOUND, by H. T.Ballantine, Jr. and E. Bell. Progress rept. Apr. 16,
1957 [17]p. incl. illus. diagrs. (AFOSR-7N-57-281)
(AF 18(603)13) AD 132352

Unclassified

The effects of lesions on functional activity of the visual cortex of cats are being studied. The lateral geniculate body and associated fibers were irradiated with ultrasound, and the activity of the visual cortex of the experimental half of the treated cat brain was compared with that of the untreated control half. Correlation analysis is being used to study the differences in response between irradiated and unirradiated sides. A typical correlogram indicated the diminution of activity of the visual cortex on the irradiated side. Results indicated that the right geniculate body is normal and that the left geniculate body shows impairment in the middle layer (i.e., to ipsilateral flash) and in the lowest layer (i.e., to contralateral flash). No function remained in the lateral geniculate on the left at F_7 , L_{10} , H_3 . The results appeared to

indicate a lesion in the lower half or even the lower one-third of the left geniculate body. The upper one-third is probably unimpaired. The predictions were confirmed by gross histological examination. A distinct lesion was observed in the lateral lower one-third of the lateral geniculate body as well as in subjacent fibers. It will be possible to distinguish clearly between the contributions of the 3 respective layers of the lateral geniculate body to cortical activity. The action of ultrasound, both reversible and irreversible, is being studied on fibers of the optic tract to observe changes in conduction during and following irradiation with ultrasound, to determine the dose of ultrasound which alters conduction reversibility, and to determine the recovery time for restoration of normal functions. The maximum dose of ultrasound is being determined to which white matter can be subjected without irreversible alteration of its ability to function.

MGH.02:001

Massachusetts General Hospital. Neurophysiology Lab.,
Boston.A STUDY OF THE LATE RESPONSE TO FLASH IN THE
CORTEX OF THE CAT, by M. A. B. Brazier. [1957]
[23]p. incl. illus. diagrs. refs. (Sponsored jointly by
Air Force Office of Scientific Research under [AF 49-
(638)98], Signal Corps, and Office of Naval Research)

Unclassified

Published in Acta Physiol. Pharmacol. Neerlandica, v. 6:
692-714, 1957.

Single flashes of light evoke more than one response at the visual cortex of lightly anaesthetized cats. The second response does not travel via the lateral geniculate nucleus. The superior colliculus and subthalamus have been explored for late components in response to flash. The effect of various anaesthetics has been noted. The late response in the visual system does not appear to be diffusely projected to the cortex. (Contractor's abstract)

MGH.02:002 - MGH.02:004

MGH.02:002

Massachusetts General Hospital. [Neurophysiology Lab.]
Boston.

THE DEVELOPMENT OF CONCEPTS RELATING TO THE ELECTRICAL ACTIVITY OF THE BRAIN, by M. A. B. Brazier. [1958] 21p. refs. (Bound with its Progress rept., July 1958) (AF 49(638)98)

Unclassified

Also published in Jour. Nervous and Mental Disease, v. 126: 303-321, Apr. 1958.

The development of concepts relating to the electrical activity of the brain is presented historically, covering the period from Galvani (1791) to the present. From the information given, an attempt is made to lead up to a current hypothesis of the basic mechanisms responsible for EEG (electroencephalogram) potentials. It is stated that in the resting but awake brain the typical α rhythm is compounded of the massed synaptic potentials of the apical dendrites of pyramidal cells, synchronization resulting from the electrical field of maximal amplitude present in the total activity. The constant influx of stimuli from the external and internal environment of the organism reaches the pyramidal cells through the specific afferents (probably with an intercalary Golgi type-2 cell), and the resultant post-synaptic depolarization moves toward the cortical surface by electrotonic spread in the apical dendrites. The degree of depolarization of the dendritic tree (the substratum of the EEG) is controlled by the arrival via nonspecific afferents of facilitatory and inhibitory impulses from the brain stem modifying the level of excitability. This type of afferent plays onto the dendrites by axo-dendritic dynapsis in the superficial layers of the cortex, adding algebraically to the summing level of polarization. At the same time, any excessive development of discharge by the pyramidal cells is checked by their hyperpolarizing action of the small inhibitory cells activated by recurrent collaterals of these same pyramidal cells. The relative courses of these 3 events with their different rates of recovery set the rhythm of the waking brain. Variations from this homeostatic condition are discussed for the following: (1) sleep or coma; (2) vigilance; (3) selective attention; (4) efferent output; (5) photic driving; (6) conditioned reflexes; (7) barbiturate anesthesia; (8) cortical spiking in epilepsy; (9) petit mal absences; (10) brain tumors; and (11) destructive lesions. A bibliography of 108 references, ranging in time from 1791 to 1956 is also included.

MGH.02:003

Massachusetts General Hospital. [Neurophysiology Lab.]
Boston.

EEG STUDIES OF FLICKER IN NORMAL MAN, by M. A. B. Brazier. [1958] 5p. diagrs. (Bound with its Progress rept. July 1958) [AF 49(638)98] Unclassified

Also published in ERDL-Tulane Symposium on Flicker, Tulane, 1957, p. 199-224.

Two methods of analysis were employed in these studies involving photic stimulation during EEG (electroencephalogram) recording, one being in the frequency domain, the other being in the time domain. The equipment and procedures are briefly described. Results of the analyses are discussed. It is pointed out that the frequency-domain analysis reports the activity/unit time whose oscillations resonate with the tuned circuits of the instrument. Lost in this type of analysis is all information as to phase of the waves, and therefore of trains of waves of the same frequency. Bursts of α with interposed waves of different frequencies are not differentiated by this type of analyzer from continuous trains of waves locked in phase with each other. In the time-domain analysis, information is presented about the voltage-time graph of the EEG throughout the whole length of the sample, indicating whether amplitude fluctuations in the EEG are related patternwise to those that have come before.

MGH.02:004

Massachusetts General Hospital. [Neurophysiology Lab.]
Boston.

THE EFFECT OF THYROID HORMONES AND TEMPERATURE ON THE KINETICS OF CONTRACTION AND RELAXATION OF VENTRICULAR HEART MUSCLE, by W. R. Brewster, Jr., J. P. Isaacs and others. [1958] 30p. incl. diagrs. refs. (Bound with its Progress rept., July 1958) (AF 49(638)98) and AF 18(600)1258)

Unclassified

Also published in Bull. Johns Hopkins Hospital, v. 103: 157-182, Oct. 1958.

The kinetics of isometric contraction and relaxation have been observed in intact athyroid, euthyroid, and thyroid-fed dogs utilizing Walton strain gauge arches sutured to segments of both right and left ventricular heart muscle. The animal's heart and body temperatures were varied from 42°C to 17°C. Isometric contraction and relaxation of muscle displayed 4 distinct phases for analysis: (1) initial contraction characterized by a rapid and near maximal increase in tension; (2) contracted state during which a further slow increase in tension may occur; (3) relaxation; and (4) relaxed state. The temperature coefficients (Q10) and Arrhenius activation energy (u) values were calculated for the duration of the above states, for the tensions developed, and for the oxygen consumption/ml/sq m/min. The Q10 values for the duration of the phase of initial contraction and for the tension developed varied from 1.09 to 1.38, with (u) values of 2,600 calories to 6,040 calories. In contrast, the duration of the contracted state and the time required for isometric relaxation had Q10 values varying from 2.7 to 3.4, and (u) values of 18,390 to 22,100 cal/mol. A linear, inverse, exponential relationship existed between the metabolic rate and either the duration

MGH.02:005, 006; MIT.02:002

of the contracted state or the time required for relaxation. Contraction possesses the characteristic of a physical process involving ionic interaction, diffusion, or viscous flow. Relaxation has the kinetic characteristics of an enzymatic reaction associated with and dependent upon chemical bond energy or electron transfer. Relaxation of ventricular heart muscle thus has the characteristics of an active metabolic process, its rate being related directly to thyroid hormone activity and temperature. (Contractor's abstract)

MGH.02:005

Massachusetts General Hospital. [Neurophysiology Lab.] Boston.

RHYTHMIC ACTIVITY INDUCED BY PHOTIC STIMULATION IN RELATION TO INTRINSIC ALPHA ACTIVITY OF THE BRAIN IN MAN, by J. S. Barlow. [1958] 6p. diags. (Bound with its Progress rept., July 1958) [AF 49(638)98] Unclassified

Presented at annual meeting of the Biophys. Soc., Cambridge, Mass., Feb. 1958.

Also published in EEG Clin. Neurophysiol., v. 12: 317-326, 1960.

The relationship between intrinsic rhythmic activity and the response to slow rates of repeated light flashing has been studied in man, using recordings made from scalp electrodes on the occiput. As a measure of rhythmic activity, and in particular, its frequency, autocorrelations were made from magnetic tape recordings of the original data. For study of responses evoked by stroboscopic stimulation, a great number of individual responses were averaged electronically by means of a modification of the same computer used to obtain the autocorrelations. The results obtained indicate a close relationship between intrinsic activity or α activity of the occipital cortex, and the activity which is induced by photic stimulation, at least so far as their respective frequencies are concerned. These results are in agreement with earlier research by others conducted on experimental animals, in which a similarly strong relationship was found in many instances, suggesting that the generators of these 2 types of electrical activity have similar properties. A great deal more information is necessary, however, in order to state whether or not the 2 generators are identical. (Contractor's abstract)

MGH.02:006

Massachusetts General Hospital. [Neurophysiology Lab.] Boston.

THE USE OF CATION EXCHANGE RESIN PURIFICATION FOR THE FLUORIMETRIC ANALYSIS OF URINARY CATECHOL AMINES, by C. H. Du Toit. [1958] 14p. tables, refs. (Bound with its Progress rept.

July 1958) (Sponsored jointly by Wright Air Development Center under AF 33(616)5003 and [Air Force Office of Scientific Research] under AF 49(638)98)

Unclassified

A method is presented for estimating adrenalin and noradrenalin in urine. It employs an ion exchange resin, Amberlite XE-64, for purification. The subsequent chemical analysis is based on the well-known fluorimetric method. The simultaneous estimation of the 2 hormones is accomplished by a multiple-filter technique of fluorimetry. The selection of appropriate sets of filters is based on careful study of the fluorescence spectra of the compounds concerned. Evidence indicates that a high degree of specificity has been attained. The method has been extensively employed in the diagnosis of pheochromocytoma. In 150 control patients, the highest 24-hr excretion values were 17 μ g. of adrenalin and 100 μ g. of noradrenalin. Seven cases of pheochromocytoma have been studied. The importance of small excesses of adrenalin is apparent in one of these cases. The possible significance of low noradrenalin excretion is discussed. (Contractor's abstract, modified)

MIT.02:002

Massachusetts Inst. of Tech., Cambridge.

CYCLES ON ABELIAN VARIETIES, by A. Mattuck. [1958] [11]p. (AF 18(603)91) Unclassified

Published in Proc. Amer. Math. Soc., v. 9: 88-98, Feb. 1958.

Algebraic homology with rational coefficients of the general complex Abelian variety are studied. It is found that in each complex dimension the only homology classes represented by algebraic subvarieties are the lone homology class of the linear section of that dimension and its rational multiples. Further the only homology classes of the torus "lying on" these subvarieties are those arising from the intersection of the subvarieties with the homology classes of the torus. The following theorem and corollary are demonstrated. Theorem: On the general Abelian variety V^n let $\sigma = \sum a_j \langle J \rangle$ be a basic rational p-cycle. If for each I of the type $(p-1,1)$, where $i = (p-n)^+, \dots, r-1$, we have the relation $\sum_j a_j [1, J] = 0$ among the minors of the doubled Riemann matrix M , then $\sigma \sim E^{p-r} \cdot \tau$, where τ is a rational cycle. Corollary: The rank of the group of homology classes represented by p-cycles of rank r on the general Abelian variety V^n is $\binom{2n}{p-2r}$.

MIT.02:003, 004; MIT.13:001

MIT.02:003

Massachusetts Inst. of Tech., Cambridge.

ON TRANSITIVE TRANSLATION FUNCTIONS, by J. W. Schlesinger. [1958] [4]p. (AF 18(603)91)

Unclassified

Published in Proc. Amer. Math. Soc., v. 9: 507-510, May 1958.

Let p be a continuous map of the space E onto B . According to the definition of W. Hurewicz (Proc. Nat'l. Acad. Sciences, v. 41: 956-961, 1955) the triple (E, B, p) is a fibre space if there exists a continuous lifting function λ which assigns to each pair (e, ω) (consisting of a point $e \in E$ and a path ω in B starting at the point $p(e)$) a path $\lambda(e, \omega)$ in E starting at e such that $\lambda(e, \omega)$ projects onto ω . For any two points $b_0, b_1 \in B$ and any path ω from b_0 to b_1 , one may define a "translation function"

$\tau(\omega): p^{-1}(b_0) \rightarrow p^{-1}(b_1)$ by the formula $[\tau(\omega)](e) = [\lambda(e, \omega)](1)$ for any $e \in p^{-1}(b_0)$. This translation function is said to be transitive if for any three points $b_0, b_1, b_2 \in B$ and paths ω_1 from b_0 to b_1 and ω_2 from b_1 to b_2 , $\tau(\omega_1 \omega_2) = \tau(\omega_2) \circ \tau(\omega_1)$ (where $\omega_1 \omega_2$ is the path obtained by traversing ω_1 and ω_2 in succession). This paper supplies the following answer to the question of when transitive translation functions exist for fiber bundles: If a bundle over a finite polyhedron has a structural group G with no small subgroups, then it has a transitive translation function if and only if it is equivalent in G to an H bundle where H is a totally disconnected subgroup of G . The central result of this paper is that if τ is a transitive translation function and the structural group has no small subgroups, then $\tau(\omega)$ depends only on the homotopy class of ω .

MIT.02:004

Massachusetts Inst. of Tech., Cambridge.

ON HOMOGENEOUS RIEMANNIAN MANIFOLDS, by W. Ambrose and I. M. Singer. [1958] [23]p. (AF 18-(603)91)

Unclassified

Published in Duke Math. Jour., v. 25: 647-669, Dec. 1958.

A homogeneous Riemannian manifold can be characterized in terms of the behavior of the curvature under parallel translation. The manifold M is characterized through the existence of a certain function T which assigns to each x in any tangent space an anti-symmetric linear transformation T_x which satisfies the following relations

$$\Delta_z R_{x,y} = -R_{T_z x, y} + R_{T_z y, x} - [R_{x,y}, T_z] \text{ and}$$

$$\Delta_y T_x = -T_{T_y x} + [T_y, T_x] \text{ where } R_{x,y} \text{ is the curva-}$$

ture of M and Δ_x is the covariant derivative. Inversely, if M is a complete and simply connected Riemannian manifold and if there exists a transformation T_x satisfying the above conditions, then M is linear and homogeneous. If $T_x = 0$, then M is symmetric. Two separate proofs are given for the above. The first proves that M is homogeneous by constructing a Lie group G such that M is isometric and for which M is a quotient space. The second shows that the curvature parallel translates the same way along singly broken geodesics emanating from any two points of M and shows that there is an isometry carrying any point into any other.

MIT.13:001

Massachusetts Inst. of Tech., Cambridge.

SUBLIMATION MASS TRANSFER THROUGH COMPRESSIBLE BOUNDARY LAYERS ON A FLAT PLATE, by T. K. Sherwood and O. Träss. Final rept. Sept. 1, 1958, 317p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-131) (AF 48(638)234) AD 203713

Unclassified

Data are obtained on rates of mass transfer from a flat plate to air at speeds up to Mach 3.5. The range of the present knowledge of mass transfer was extended by this data, and a means of checking compressible flow theories was provided. Naphthalene was sublimed from an adiabatic sharp-edged flatplate model exposed to subsonic and supersonic air streams in a continuous-type wind tunnel. Sensitive strain gages equipped with pick-up needles touching the naphthalene surface were used to obtain surface profile traces. One such trace was made before and after each test, their difference giving the thickness decreases of the naphthalene coating and thus the amount sublimed. The resulting profiles of naphthalene thickness decrease gave a continuous sequence of point mass transfer coefficients in the laminar region, through the transition zone, and in the turbulent region. Thus, continuous local friction coefficients over these flow regimes as well as an accurate demarcation of the transition zone were obtained. Experimental results agreed closely with the developed theory.

Massachusetts inst. of Tech., Cambridge.

N6ori-10513, Project Squid see under Princeton U. James Forrestal Research Center, N. J. (Project SQUID) item nos. PR1.11:210-211.

MIT.14:001; MIT.15:001;
MIT.16:001, 002

MIT.14:001

Massachusetts Inst. of Tech. Aeroelastic and Structures
Research Lab., Cambridge.

AN EXPLORATORY INVESTIGATION ON SOME AERO-DYNAMIC HEATING EFFECTS ON FLUTTER, by S. I. Gravitz. Sept. 1958, 83p. incl. illus. diagrs. tables, refs. (Technical note no. 74-1) (AFOSR-TN-58-972) (AF 49-(638)219) AD 205600 Unclassified

An experimental and theoretical investigation is made of the effects of rapid change in Mach number on the flutter characteristics of supersonic wings; and the feasibility of utilizing a heated model in a low stagnation temperature wind tunnel to observe aerodynamic heating effects is studied. Some existing theoretical techniques are briefly reviewed and applied to the simple case of a high aspect ratio solid double wedge wing undergoing rapid deceleration from a high Mach number to a lower one. The wing is flutter unstable both at the lower and higher Mach numbers, but the thermal stresses experienced in the transition are such as to make the wing transiently stable. Estimates of heat transfer coefficients and recovery factors are used to evolve approximate transient temperature and stress distribution which result in changes in the effective stiffness of the wing. Piston flutter theory is adapted to give convenient expressions for quantitative estimates of these changes. A series of experiments conducted in the M.I.T. Supersonic Blowdown Wind Tunnel show that for a model wing heated to a uniform temperature of about 500° and then injected into the airstream, the flutter behavior is appreciably different from that of an identical cold wing. The observed changes, while substantial, are not so large as predicted by the theory used. Some comments are made on factors tending to alleviate aerodynamic heating effects on flutter.

MIT.15:001

Massachusetts Inst. of Tech. Aeronautical Engineering
Dept., Cambridge.

OPTIMIZATION OF SPACE VEHICLE DESIGN WITH RESPECT TO PROPULSION SYSTEM, by P.E. Sandorff. July 1, 1958, 10p. incl. diagrs. tables. (AFOSR-TN-58-580) (AF 49(638)363) AD 158402 Unclassified

A mathematical analysis was made of propulsion systems necessary to move a desired useful payload to a given destination in as feasible and as efficient a manner as possible. The specific impulse is the most significant factor in the performance of the propulsion system of contemporary chemical rockets. Optimum specific impulse was shown to depend on the particular duty for which the engine was designed. Typical characteristics for various types of reaction engines as they are currently conceived are presented.

MIT.16:001

Massachusetts Inst. of Tech. Corrosion Lab., Cambridge.

AUSTENITIC Cr-Fe-Ni ALLOYS RESISTANT TO STRESS CORROSION CRACKING IN MAGNESIUM CHLORIDE, by H. H. Uhlig, R. A. White, and J. Lincoln, Jr. Jan. 15, 1957, 9p. incl. table. (AFOSR-TN-57-37) (AF 18(600)1221) AD 115075 Unclassified

Also published in *Acta Metallurgica*, v. 45: 473-475, Aug. 1957.

The results of corrosion studies on Cr-Ni-Fe alloys are given. Austenitic or ferritic Cr-Ni-Fe alloys were produced which resisted cracking for a period of one week or more in a test solution of boiling 42% MgCl₂. The

authors suggest that a precipitation process is probably responsible for susceptibility to cracking and the phase transformation from austenitic to ferritic during cold working plays a role, but is not a necessary condition for susceptibility.

MIT.16:002

Massachusetts Inst. of Tech. Corrosion Lab., Cambridge.

STRESS CORROSION CRACKING OF AUSTENITIC STAINLESS STEELS, by H. H. Uhlig, J. Lincoln, Jr., and R. A. White. Apr. 1, 1957 [53]p. incl. diagrs. tables, refs. (AFOSR-TR-57-24) (AF 18(600)1221) AD 120498 Unclassified

Resistance of the Cr-Ni-Fe austenitic alloys to stress corrosion cracking is markedly improved if the alloys are plastically deformed at low temperatures, such as in liquid nitrogen. The alloys of 18-8 composition can be made immune to cracking, whether stressed at high or low temperatures, by reducing nitrogen and carbon contents to about 0.01% or less. For the stable austenitic compositions such as 20% Cr-20% Ni, nitrogen rather than carbon appears to be the responsible interstitial component causing cracking. When nitrogen is reduced to 0.01% or less in this composition alloy, no cracking occurs within the maximum test period of several days. It appears that paths along which stress corrosion cracks form are established by a precipitate in which N or C participate. Nitrogen and carbon, aided by cold work, diffuse to clusters of dislocations induced by plastic deformation, where they are in favorable position and concentration for precipitation as carbide or nitrides should the lattice be deformed further. The diffusion and precipitation processes are inhibited at low temperatures. Alloyed nickel increases resistance to stress corrosion cracking apparently by inhibiting nucleation of carbides or nitrides.

MIT.16:003; MIT.17:001, 002;
MIT.18:001

MIT.16:003

Massachusetts Inst. of Tech. Corrosion Lab., Cambridge.

CHEMICAL FACTORS AFFECTING STRESS CORROSION CRACKING OF 18-8 STAINLESS STEELS, by H. H. Uhlig and J. Lincoln, Jr. [1957] [8]p. incl. illus. diagrs. table, refs. (AF 18(600)1221) Unclassified

Published in Jour. Electrochem. Soc., v. 105: 325-332, June 1958.

Transgranular stress corrosion cracking of 18-8 Type 304 specimens in boiling 42% $MgCl_2$ does not depend on rate of stressing (< 1 sec to 10 min) nor on small variations in degree of plastic deformation. Cold worked specimens fail in shorter times than annealed, sheared specimens. Addition of HCl to $MgCl_2$ decreases cracking time whereas addition of NaOH increases the time. Pre-exposure of unstressed specimens to $MgCl_2$ slightly de-

creases cracking times of the same specimens subsequently stressed. Cracks occur along sheared edges of unstressed specimens despite stress relief anneal at 375°C for 2 hr. Cracks propagate along sheared edges of U-bend specimens at 0.5 to 1 cm/hr through that portion of the specimen cross section in tension, the rate being much slower through the remaining cross section. No induction time for cracks to initiate was observed. Sizeable pits are not necessary for cracking in $MgCl_2$, but appear to be essential in media like NaCl

which in absence of pitting is not particularly active in causing cracking. The pitting mechanism produces concentrated low pH metal chlorides (e.g., $FeCl_2$)

within the pit, which like $MgCl_2$ cause immediate cracking. Oxygen is required for pitting of 18-8 by NaCl solutions as shown by Uhlig and Morrill, and hence also for stress corrosion cracking as observed by Williams and Eckel, but oxygen is not necessary in $MgCl_2$ or $FeCl_2$.

Cracking can be prevented by cathodic protection at a C.D. of 0.03 ma/cm² or higher. Anodic C.D. up to 0.01 ma/cm² were found to have no effect on cracking tendency, nor did coupling of 18-8 to Pt.

MIT.17:001

Massachusetts Inst. of Tech., Dept. of Economics and Social Science, Cambridge.

AUDITORY GENERALIZATION IN THE PIGEON, by H. M. Jenkins and R. H. Harrison. Apr. 1957, 3p. (AFOSR-TN-57-182) (AF 18(603)85) AD 126477

Unclassified

Using a Skinner key-pecking apparatus, generalization gradients are plotted in terms of the rate of response in extinction to tones of different frequencies. The effects of two training procedures are examined. In one,

a discrimination between the presence and absence of a tone is formed using differential reinforcement. The other procedure does not involve discrimination training. Without prior discrimination training, generalization tests revealed no systematic change in response rate over the test stimuli. On the other hand, with prior discrimination training an orderly gradient of response rate along the dimension of tonal frequency was found. (Contractor's abstract)

MIT.17:002

Massachusetts Inst. of Tech. Dept. of Economics and Social Science, Cambridge.

AUDITORY GENERALIZATION IN THE PIGEON, by H. M. Jenkins and R. H. Harrison. Final rept. Apr. 30, 1958, 29p. incl. diagrs. tables, refs. (AFOSR-TN-58-443) (AF 18(603)85) AD 158248 Unclassified

A test was made of the hypothesis that differential training would produce steeper gradients of auditory generalization on frequency than those produced by non-differential training. The subjects were experimentally naive, 2-yr old, white carneau pigeons. A Skinner automatic key-pecking apparatus was used to study the auditory generalization along the frequency dimension of pure tones. The generalization gradients were obtained in extinction by observing responses to test stimuli consisting of various frequencies and a no-tone condition. Data from 2 experiments tend to confirm the hypothesis. The effect of differential training in greatly sharpening generalization gradients was attributed to its role in placing auditory stimulus, as a whole, in control of the response. Steep gradients of generalization were obtained following nondifferential training with visual stimuli. Localization of the visual stimulus on the response key was considered to be an important determinant of the difference in the behavior of auditory and visual stimuli.

MIT.18:001

Massachusetts Inst. of Tech. [Dept. of Mathematics] Cambridge.

SUMS OF THREE SQUARES, by N. C. Ankeny. [1957] [4]p. (AF 18(603)90) Unclassified

Published in Proc. Amer. Math. Soc., v. 8: 316-319, Apr. 1957.

The author gives a proof of Legendre's theorem that every positive integer m which is not of the form

$4^a(8n+7)$ is representable as a sum of three integral squares; this proof uses only Minkowski's theorem on the existence of an integer point in a convex body, Dirichlet's theorem on the existence of primes in an arithmetic progression, and simple facts on quadratic reciprocity and on representation by two squares. The details are

MIT.18:002; MIT.19:001, 002

given for $m \equiv 3 \pmod{8}$ and square-free, the modifications for other cases being briefly indicated. The essential idea is to represent m as

$$R^2 + 2(qx^2 + bxy + hy^2),$$

where R is a linear form in x, y, z , and q, b, h are suitable integers satisfying $b^2 - 4qh \equiv -m$. The construction of these is such as to permit a proof that $qx^2 + bxy + hy^2$ has no prime factor $\equiv 3 \pmod{4}$ dividing it to an odd power exactly, whence it follows that $2(qx^2 + bxy + hy^2)$ is a sum of two squares. (Math. Rev. abstract)

MIT.18:002

Massachusetts Inst. of Tech. [Dept. of Mathematics] Cambridge.

A SCALAR TRANSPORT EQUATION, by Z. A. Melzak. [1957] [14]p. [AF 18(603)90] Unclassified

Published in Trans. Amer. Math. Soc., v. 85: 547-560, July 1957.

This paper is concerned with the existence and uniqueness of the solutions of the following equation

$$(1) \quad \frac{\partial f}{\partial t} = [f(x, t), f(x, t)] + Lf(x, t),$$

where $[f, g]$ and Lf are given by

$$[f, g] = \frac{1}{2} \left\{ \int_0^x f(y)g(x-y)\varphi(y, x-y)dy - f(x) \int_0^x g(y)\varphi(x, y)dy - g(x) \int_0^x f(y)\varphi(x, y)dy \right\}$$

$$Lf = \int_0^x f(y)\psi(y, x)dy - \frac{f(x)}{x} \int_0^x y\psi(x, y)dy.$$

Here the variables x, y, t are non-negative and the functions $f(x, 0)$, $\varphi(x, y)$ and $\psi(x, y)$ are assumed to be known. The functions φ and ψ are assumed to satisfy the following hypotheses: (H_1) $\varphi(x, y)$ is continuous,

$$0 \leq \varphi(x, y) = \varphi(y, x) \leq \sup \varphi(x, y) = A < \infty;$$

(H_2) $\psi(x, y)$ is continuous,

$$0 \leq \psi(x, y) \leq \sup \psi(x, y) = C < \infty,$$

$$\int_0^x y\psi(x, y)dy \leq x, \int_0^x \psi(x, y)dy \leq E - 1 < \infty.$$

The proof of uniqueness depends on the following key lemma: Let $f(x, 0)$ be a continuous, non-negative bounded and integrable function. Let $0 < 0 \sup f(x, 0) = B < \infty$ and $\int_0^\infty f(x, 0)dx = N < \infty$. Let $\varphi(x, y)$ and $\psi(x, y)$ satisfy hypotheses (H_1) and (H_2) . Then there exists a

number $m = m(A, B, C, N, E)$, $0 < m < \infty$, such that (1) possesses a solution $f(x, t)$ valid on the interval $0 \leq t < 1/m$. This solution is continuous, analytic in t for each x , and integrable in x for each t . The proof of this lemma consists in constructing a solution. By direct substitution it can be verified that the series (2) $f(x, t) =$

$\sum_{k=0}^{\infty} a_k(x)t^k$ represents a formal solution of the equation, where

$$a_0(x) = f(x, 0), a_{k+1}(x) = \frac{1}{k+1} \left\{ \sum_{i+j=k} [a_i, a_j] + La_k \right\}.$$

It is shown that the series (2) is uniformly convergent on the interval $0 \leq t < 1/m$ and satisfies all the conditions of the lemma. This solution is then continued for $t < 1/2m$ and successively to larger values of t ; and the uniqueness of the solution is established by showing that the local existence intervals cover the whole interval $0 \leq t < \infty$. (Math. Rev. abstract)

MIT.19:001

Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge.

AN EXTENSION OF A THEOREM OF MANDELBROJT, by R. A. Kunze. Oct. 30, 1957, 8p. (AFOSR-TN-57-650) (AF 49(638)42) AD 136710 Unclassified

Also published in Proc. Amer. Math. Soc., v. 9: 553-557, Aug. 1958.

Mandelbrojt has given several interesting theorems concerning Fourier transforms and analytic functions. A generalization to n -dimensions has been given of a theorem concerning the analytic continuation into the right half-plane of a function $F \in L_{\infty}$. Let G be an E_n

which is to be considered as a vector group. The dual of a cone C in G is a cone C' in the dual group G' consisting of all x such that $(x, t) \geq 0$ for all t in C . Let $T(C')$ be the set of all complex vectors $x + iy$ with $x \in C'$ and $y \in C'$ and $y \in G'$. Let $S(C)$ be the set of the complex vectors $v + iy$, where v is the apex of C and $y \in G'$. This generalization can be accomplished as follows: either $F \in E_{\infty}(G')$ or C , a closed cone, convex with G from the vertex to the origin, and the interior of which is non-empty, or a is an element of C . Suppose each $t \in C$ - a corresponds to a function $K \in L_1(G')$ where $K \circ F = 0$,

with $k(t) \neq 0$, where k is the inverse Fourier transformation of K . There exists then an analytic function F_0 on the interior of $\Gamma(C)$.

MIT.19:002

Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge.

FRACTIONAL INTEGRALS ON N -DIMENSIONAL EUCLIDEAN SPACES, by E. M. Stein and G. Weiss.

MIT.19:003, 004; MIT.05:003

 Dec. 2, 1957, 21p. (AFOSR-TN-57-689) (AF 49(638)42)
 AD 136718 Unclassified

 Also published in Jour. Math. and Mech., v. 7: 503-514,
 July 1958.

Let x denote a general point in Euclidean n -space E^n , let $|x|$ be the absolute value of the vector point x , and let dx be the n -dimensional volume element. Let $T_\lambda f(x) = \int f(y) |x - y|^{-\lambda} dy$. The principal result of the present paper is as follows. Let $0 < \lambda < n$, $1 < p < \infty$, $\alpha < n - n/p$, $\beta < n/q$, $\alpha + \beta \geq 0$, $1/q = 1/p + (\lambda + \alpha + \beta)/n$ - 1. If $p \leq q < \infty$, then $\|T_\lambda f(x) |x|^\beta\|_q \leq A \|f(x) |x|^\alpha\|_p$, where A depends upon p , α , β , and λ but not upon f . The demonstration splits into two cases $q = p$ and $q > p$, the former being the more difficult. In the course of the demonstration a number of inequalities are generalized from 1 to n dimensions which are of independent interest. For example, it is proved that if $K(u, v) \geq 0$ is defined for $u \geq 0$, $v \geq 0$, is homogeneous of degree $-n$, and satisfies, for some $p \geq 1$, $\int_0^\infty K(1, t) t^{n-1-n/p} dt < \infty$, and if $Uf(x) = \int K(|x|, |y|) f(y) dy$, then $\|Uf\|_p \leq A \|f\|_p$. (Math. Rev. abstract)

MIT.19:003

 Massachusetts Inst. of Tech. Dept. of Mathematics,
 Cambridge.

ON THE INTERPOLATION OF ANALYTIC FAMILIES
 OF OPERATORS ACTING ON H^p SPACES, by E. M.
 Stein and G. Weiss, Dec. 2, 1957, 43p. refs. (AFOSR-
 TN-57-692) (AF 49(638)42) AD 136719 Unclassified

 Also published in Tôkoku Math. Jour., v. 9: 318-339,
 1957.

Let \mathcal{P} be the class of polynomials $P(w)$ with complex
 coefficients and let

$$\|P\|_p = \sup_{0 \leq r < 1} \left\{ (2\pi)^{-1} \int_0^{2\pi} |P(re^{i\theta})|^p d\theta \right\}^{1/p} \quad (p > 0).$$

Let (M, μ) be a measure space and let $L^q(M, \mu)$ denote
 the space of all complex-valued measurable functions f
 for which

$$\|f\|_q = \left\{ \int_M |f|^q d\mu \right\}^{1/q} \quad (q > 0)$$

is finite. Let us now assume that T_z , $0 \leq \operatorname{Re} z \leq 1$, is an
 analytic family of linear transformations of \mathcal{P} into
 $L^1(M, \mu)$ which is of admissible growth; that is, for every
 $g \in L^\infty(M, \mu)$ there exist constants $0 < B$, $0 < b < \pi$, such

that $\left| \int_M (T_z g) d\mu \right| \leq B \exp b |\operatorname{Im} z|$ ($0 \leq \operatorname{Re} z \leq 1$).

The principal result of the paper asserts that if T_z is

analytic and of admissible growth; and if p_0, p_1, q_0, q_1
 are positive numbers such that for all y , $-\infty < y < \infty$,
 and all P in \mathcal{P} ,

$$\|T_{iy} P\|_{p_0} \leq A_0(y) \|P\|_{q_0}, \quad \|T_{1+iy} P\|_{p_1} \leq A_1(y) \|P\|_{q_1},$$

where $|A_i(y)| \leq C_i \exp c_i |y|$, $0 < C_i$, $0 < c_i < \pi$
 ($i = 0, 1$); then for each t , $0 < t < 1$, $\|T_t P\|_{q_t} \leq A \|P\|_{p_t}$
 where $p_t^{-1} = (1-t)p_0^{-1} + tp_1^{-1}$, $q_t^{-1} = (1-t)q_0^{-1} +$
 tq_1^{-1} , and where A is independent of P . This gener-
 alizes earlier results of Calderón and Zygmund and
 Salem and Zygmund which dealt with the case in which
 the transform T_z is a constant function of z . (Math. Rev.
 abstract)

MIT.19:004

 Massachusetts Inst. of Tech. Dept. of Mathematics,
 Cambridge.

ON SOME PROBLEMS OF GEL'FAND, by K. Hoffman
 and I. M. Singer. July 28, 1958, 46p. (AFOSR-TN-
 58-595) (AF 49(638)42) AD 162119 Unclassified

 Also published in Uspehi Mat. Nauk, v. 14(3): 99-114,
 1959.

Questions raised on commutative Banach algebras by
 Gel'fand are answered in the paper. Sup-norm algebras
 are uniformly closed subalgebras of the algebra $C(Y)$ of
 all continuous complex-valued functions on a compact
 Hausdorff space Y , assumed to contain the constant func-
 tions. The sup-norm algebra A is used to denote $S(A)$,
 the space of maximal ideals, i.e., $S(A)$ is the set of all
 homomorphisms of the algebra A onto the complex num-
 bers with the weakest topology which makes all the ele-
 ments of A continuous on that set. The questions relate
 to the possibilities of various operations and mappings
 upon various sub-algebras and subsets of A .

MIT.05:003

 Massachusetts Inst. of Tech. Dept. of Mechanical
 Engineering, Cambridge.

FATIGUE CRACK PROPAGATION IN TORSION, by J.
 A. H. Hult. July 1957 [15]p. incl. diagrs. (AFOSR-TN-
 57-448) (AF 18(600)957) AD 136438 Unclassified

 Also published in Jour. Mech. and Phys. of Solids, v. 6:
 47-52, 1957.

The redistribution of stress and strain in front of a grow-
 ing crack in a twisted bar is derived, assuming the mate-
 rial to be ideally plastic. The result is used in connec-
 tion with a simple fracture criterion to determine the
 initial rate of growth of a fatigue crack. Experiments
 with torsion members are reported.

MIT.05:004, 005; MIT.20:001;
MIT.21:001

MIT.05:004

Massachusetts Inst. of Tech. Dept. of Mechanical
Engineering, Cambridge.

ELASTIC-PLASTIC TORSION OF SHARPLY NOTCHED
BARS, by J. A. H. Hult. July 1957 [8]p. incl. diagrs.
(AFOSR-TN-57-449) (AF 18(600)957) AD 136439
Unclassified

Also published in Jour. Mech. and Phys. of Solids, v. 6:
78-82, 1957.

Torsion of a bar with a sharp longitudinal notch produces plastic yielding at the tip of the notch for any magnitude of the applied torque, however small. It is shown that the shape of the region of incipient plastic yielding can be found for any shape of the cross section provided the solution of the corresponding elastic problem is known. The elastic stress field near the tip of a sharp notch in pure shear similar to the elastic stress field near a similar longitudinal notch in torsion. Since the shape of the plastic region produced at the notch in pure shear is known, the corresponding region in the torsion case can be derived by analogy.

Sylwestrowicz and E. Orowan. Final rept. Aug. 31, 1957
[35]p. incl. diagrs. refs. (AFOSR-TR-57-71) (AF 18-
(600)1020) AD 136618
Unclassified

Presented at meeting of the Amer. Inst. of Mining and
Metallurgical Engineers, Nov. 4, 1957.

Also published in Trans. Metall. Soc. AIME, v. 212:
617-624, Oct. 1958.

In tests on polycrystalline copper and aluminum, the ratio of the yield stress to modulus of elasticity was found to be strongly dependent on temperature. Also, it was shown that the change of the yield stress with temperature of a material at a given temperature and deformed to a given yield stress, but not necessarily to the same strain, does not depend on previous mechanical thermal history. Likewise, for a material at a given temperature and deformed to a given yield stress, the rate of work hardening is independent of the temperature of prior stressing. (Contractor's abstract)

MIT.21:001

Massachusetts Inst. of Tech. Dept. of Mechanical
Engineering, Cambridge.

ANALYTICAL INVESTIGATION OF THE EFFECTS OF
A DIFFUSION FIELD ON A LAMINAR BOUNDARY
LAYER IN SUPERSONIC FLOW, by J. R. Radbill.
Jan. 13, 1958, 1v. incl. diagrs. tables, refs. (AFOSR-
TN-58-131) (Sponsored jointly by Air Force Office of
Scientific Research under AF 18(600)1493 and Office of
Naval Research under N5ori-07897) AD 152158
Unclassified

A solution is presented for supersonic flow of air in a round tube with uniform injection of a foreign gas through the wall. The flow is assumed to be divided into two regions, a boundary layer developing on the tube wall and an isentropic core. Starting from the equations of change derived from kinetic theory, the tensor equations are expanded in cylindrical coordinates and subjected to an order of magnitude analysis to produce boundary layer equations. Introduction of a stream function and power series in a modified length Reynolds number with coefficients which are functions of a wall distance parameter permit separation of the partial differential equations into an infinite series of sets of ordinary differential equations. The viscosity and thermal conductivity of the gas mixture were approximated by products of quadratics in temperature and concentration and the binary diffusion coefficient by a quadratic in temperature only. The quadratics were fitted by least square methods to predictions calculated from kinetic theory. The first three sets of differential equations were integrated numerically using the modified Adams method on the Whirlwind and later the I.B.M. 704 computer of the M.I.T. computation center. The wall boundary conditions for the linear and non-linear two-point boundary-value problems were located by repeating a process of linear

MIT.05:005

Massachusetts Inst. of Tech. Dept. of Mechanical
Engineering, Cambridge.

A THEORY OF CATASTROPHIC SHEAR FRACTURE IN
DUCTILE MATERIALS, by F. A. McClintock. July 1957
[27]p. incl. diagrs. refs. (AFOSR-TN-57-450) (AF 18-
(600)957) AD 136440
Unclassified

Also published in Jour. Appl. Mech., v. 25: 581-588,
Dec. 1958. (Title varies)

It is postulated that shear fracture occurs in a perfectly plastic material when a critical shear strain is attained throughout a critical volume of material. This postulate is combined with the classical equations of plasticity to predict when cracking will initiate from a notch at nominal shear stresses below the yield stress, when the crack will become unstable on increase of stress, and when unstable cracking will occur if a notch is cut while a constant nominal stress is maintained. Tests on aluminum foil under biaxial tensile stress show results which are qualitatively similar to those predicted by the theory.

MIT.20:001

Massachusetts Inst. of Tech. Dept. of Mechanical
Engineering, Cambridge.

THE TEMPERATURE DEPENDENCE OF THE YIELD
STRESS OF COPPER AND ALUMINUM, by W. D.

MIT.22:001 - MIT.22:004

interpolation with partial divided differences obtained from a set of solutions. At a Mach number of 5 and a stagnation temperature of 150°, the recovery factor was found to increase with injection rate and along the tube up to 15% for helium injection. The friction factor was found to decrease through zero with increasing modified length Reynolds number and increasing injection rate.

MIT.22:001

Massachusetts Inst. of Tech. [Dept. of Physics]
Cambridge.

POLARIZED BEAM NEUTRON DIFFRACTION SPECTROMETER (Abstract), by C. G. Shull, R. Nathans, and A. W. McReynolds. [1957] [1]p. (In cooperation with Brookhaven National Lab.) [AF 18(603)84]

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 21, Jan. 30, 1957.

A description will be given of one of the BNL neutron diffraction spectrometers which has been modified for use as a polarized beam spectrometer. By using a magnetized, ferromagnetic crystal of suitable scattering properties as a monochromator, a beam of high polarization value is available for further study. Crystals of Fe_3O_4 have been used as polarizing monochromators and, when due allowance is made for internal depolarization (arising from incomplete magnetic saturation), the theoretical polarization of 100% is accounted for within experimental error of 1%. The magnetic scattering by crystals of iron and nickel has been studied and the magnetic scattering effects are found to be much enhanced over that found with unpolarized radiation. Other advantages of the polarized beam technique will be outlined.

MIT.22:002

Massachusetts Inst. of Tech. Dept. of Physics,
Cambridge.

THE MAGNETIC STRUCTURE OF Fe_3Al , by R.

Nathans, M. T. Pigott, and C. G. Shull. Sept. 24, 1958 [5]p. incl. diagrs. tables. (Technical rept. no. 1) (In cooperation with Brookhaven National Lab.) (AFOSR-TN-58-194) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)84, Atomic Energy Commission, National Security Agency, and Bureau of Ordnance) AD 152227

Unclassified

Also published in Jour. Phys. Chem. Solids, v. 6: 38-42, July 1958.

A polarized-neutron-beam spectrometer has been used

to determine the room-temperature magnetic structure of ordered Fe_3Al . The results show that the aluminum atoms possess no magnetic moment and that the iron moments differ for the two sublattice sites. On one sublattice, where the iron atoms are surrounded by both iron and aluminum nearest neighbors, the average moment/atom is found to be $1.46 \pm 0.1\mu\text{B}$. On the other sublattice, where the iron atoms have only iron atoms as nearest neighbors, the average moment/atom is found to be $2.4 \pm 0.1\mu\text{B}$. The data taken on higher-order magnetic reflections also permitted a comparison of the magnetic form factors for each of the different sites with that of metallic iron. No difference was observed to within the $\pm 2\%$ accuracy of the measurements on the form factor. (Contractor's abstract)

MIT.22:003

Massachusetts Inst. of Tech. [Dept. of Physics]
Cambridge.

THE CONFIGURATION OF THE TRIODIDE GROUP IN TETRAPHENYL ARSONIUM TRIODIDE $(\text{C}_6\text{H}_5)_4\text{AsI}_3$, by R. C. L. Slater. Oct. 26, 1958 [22]p. incl. diagrs. tables, refs. (Technical rept. no. 2) (AFOSR-TN-58-834) (AF 18(603)84) AD 202919; PB 138134

Unclassified

Presented at Pittsburgh Diffraction Conf., Pa., Nov. 1957.

Also published in Acta Crystallographica, v. 12: 187-196, Mar. 10, 1959. (Title varies)

The space group symmetry of $(\text{C}_6\text{H}_5)_4\text{AsI}_3$ is found to be $P2_1/n$ and has two formula weights per unit monoclinic cell. A trial structure was deduced from two dimensional Patterson and Fourier series and refined by means of Fourier difference series. The I_3 ion in this crystal is found to have equal bond lengths as compared to unequal bond lengths in crystals in which the cation is smaller. The bond length difference in various crystals is discussed with respect to the crystal environment, and an explanation is given which is based on the general behavior of a simple linear triatomic system. (Contractor's abstract, modified)

MIT.22:004

Massachusetts Inst. of Tech. Dept. of Physics,
Cambridge.

POLARIZED NEUTRON STUDIES ON ANTIFERROMAGNETIC SINGLE CRYSTALS, by R. Nathans, T. Riste and others. Nov. 26, 1958 [11]p. incl. diagrs. refs. (Technical rept. no. 4) (In cooperation with Brookhaven National Lab.) (AFOSR-TN-58-1058) (AF 18(603)84) AD 206986; PB 140015

Unclassified

MIT. 23:001, 002; MIT. 24:001

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 21-22, Jan. 30, 1957.

The theory of neutron scattering by magnetic crystals as given by Halpern and Johnson predicts changes in the polarization state of the neutron beam upon scattering which depend upon the relative orientation of the neutron polarization vector and the crystal magnetic axis. This effect was investigated experimentally with a polarized beam spectrometer using single crystals of Cr_2O_3 and $\alpha - \text{Fe}_2\text{O}_3$ in which reside unique antiferromagnetic axes. Studies were made on several different reflections in both crystals for a number of different temperatures both below and above the Néel point. Results support the theoretical predictions and indicate directions for the moments in these crystals consistent with previous work. In addition to the above, a more detailed study of the polarization changes in the reflection in $\alpha - \text{Fe}_2\text{O}_3$ at room temperature on application of a magnetic field has also been carried out. The results indicate that the principal source of the parasitic ferromagnetism in hematite is essentially independent of the orientation of the antiferromagnetic domains within the crystal. (Contractor's abstract)

classical theory; it stems from the fact that the concept of homogeneous phase corresponds only within certain limits to the actual distribution of matter. (Contractor's abstract)

MIT.23:002

Massachusetts Inst. of Tech. Dept. of Physics, Cambridge.

GENERALIZED PHASE RULE AND THE SYMMETRY OF THE SUPERFLUID STATE, by L. Tisza. [1958] 6p. incl. refs. (Sponsored jointly by Signal Corps, Air Force Office of Scientific Research, and Office of Naval Research under [DA 36-039-sc-64637] and Air Force Office of Scientific Research under [AF 49(638)95]) AD 152218 Unclassified

Also published in Phys. Rev., v. 110: 587-589, Apr. 15, 1958.

Phases which are otherwise identical may differ by symmetry, crystalline twin phases being a familiar example. The existence of these phases can be taken into account by assigning to a system a "symmetry number" which would ordinarily be 0. An ordered binary mixed crystal is regarded as a 2-phase system, the phases consisting of domains with different type of order; these crystals are assigned a symmetry number equal to unity. Gibb's deduction of the phase rule is reformulated so that the effect of the symmetry is taken into account. Broadly speaking a symmetry number equal to 1 gives rise to an additional degree of freedom. If 2 coexisting phases tend to become identical, the boundary of their coexistence is known as "critical phase." In vapor-liquid equilibrium the critical phase is restricted to a point. In accordance with the author's generalized phase rule the critical phase for an ordered crystal has 1 degree of freedom and is known as the λ -curve. On account of the similarity between the λ -transitions of liquid helium and of mixed crystals, it is concluded that the ground state of liquid helium must be doubly degenerate, contrary to all current views on the nature of superfluids. It is asserted that the phase rule is not a direct consequence of the laws of thermodynamics.

MIT.23:001

Massachusetts Inst. of Tech. Dept. of Physics, Cambridge.

THEORY OF λ -POINTS AND THE SYMMETRY OF THE SUPERFLUID STATE, by L. Tisza. [1957] [3]p. incl. table. (Sponsored jointly by [Signal Corps, Air Force Office of Scientific Research, Office of Naval Research under DA 36-039-sc-64637] and Air Force Office of Scientific Research under AF 49(638)95) Unclassified

Published in Proc. Fifth Internat'l. Conf. on Low Temperature Phys. and Chem., Madison, Wis. (Aug. 26-31, 1957), Madison, Univ. of Wisconsin Press, 1958, p. 124-126.

The classical Gibb's theory predicts the possible types of phase equilibria from principles of thermodynamic stability. The only major shortcoming is the failure to account for the λ -points in solids and in liquid helium. It is possible to complete the Gibb'sian program and subsume λ -points under thermodynamic stability considerations, provided the definition of phase is sharpened to include intrinsic coordinates specifying the symmetry properties of the system. The use of such non-classical parameters in thermodynamics has been tried before, but usually in conjunction with simplifying assumptions leading to a loss of thermodynamic rigor. The present theory is developed rigorously from a set of postulates applicable to experience within well understood limits of validity. This last proviso is inherent even in the

MIT.24:001

[Massachusetts Inst. of Tech. Dept. of Physics, Cambridge].

INTERNATIONAL CONFERENCE ON CURRENT PROBLEMS IN CRYSTAL PHYSICS, Massachusetts Inst. of Tech., Cambridge, July 1-5, 1957. 1958 [210]p. incl. diagrs. tables, refs. (Sponsored jointly by Internat'l. Union of Pure and Appl. Phys., Internat'l. Union of Crystallography, UNESCO, National Science Foundation, Office of Naval Research, and Air Force Office of Scientific Research) Unclassified

MIT.06:013-015; MIT.07:003

Published in Rev. Modern Phys., v. 30: 46-209, Jan. 1958.

The primary aim of this conference was to bring together crystallographers and theoretical or solid-state physicists to discuss topics of common interest. Some 150 persons attended the conference, about 65 of whom were from England, Germany, Scotland, and Japan. The topics of discussion included the determination of the thermal vibrations of solids by temperature-diffuse scattering of x-rays; x-ray determination of the form factors of the outer electrons of atoms, with a view to determining nonspherical charge distributions; neutron diffraction determination of the distribution of magnetic scattering in ferromagnetic metals and alloys and in antiferromagnetic substances; and determination of hydrogen positions in crystals by x-ray, electron, and neutron diffraction.

MIT.06:013

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

FORCES AND MOMENTS ON OSCILLATING SLENDER WING-BODY COMBINATIONS AT SUPERSONIC SPEED. PART I. BASIC THEORY, by G. Zartarian and H. Ashley. Apr. 1957, 69p. incl. diagrs. table. (MIT Fluid Dynamics Research Group rept. no. 57-2) (AFOSR-TN-57-386) (AF 18(600)961) AD 132461

Unclassified

A theoretical method is developed for estimating aerodynamic loads on slender, symmetrical configurations performing small lateral oscillations of limited reduced frequency in a supersonic main stream. This procedure extends an iterative technique originally proposed by Adams and Sears, and applied by Landahl to similar configurations in transonic flow. As a practical example, stability derivatives are calculated for a plane wing centrally mounted in a body of revolution. Under certain limitations on the rapidity of the oscillations, all derivatives prove to be independent of changes in reduced frequency. Many of them, notably the acceleration derivatives, differ appreciably from the results of ordinary slender body theory, being sensitive both to changes in the wing aspect ratio and the diameter of the central body. Especially significant are the effects of these two parameters and the unsteadiness of the flow on the fixed-axis damping in pitch. (Contractor's abstract)

MIT.06:014

Massachusetts inst. of Tech. Fluid Dynamics Research Group, Cambridge.

FORCES AND MOMENTS ON OSCILLATING SLENDER WING-BODY COMBINATIONS AT SUPERSONIC SPEED. PART II. APPLICATIONS AND COMPARISON WITH

EXPERIMENT, by H. Kennet, H. Ashley, and R. L. Stapleford. Dec. 1957, 53p. incl. diagrs. tables. (MIT Fluid Dynamics Research Group rept. no. 57-5) (AFOSR-TN-58-114) (AF 18(600)961) AD 152022; PB 147041

Unclassified

Several applications and extensions are described of a theoretical method for estimating aerodynamic loads on slender wing-body configurations performing small oscillations of limited reduced frequency in a supersonic main stream. This procedure involves an iterative technique in ascending orders of aspect ratio and frequency, originally applied to similar shapes in transonic flow. The theory is moderately successful as compared with experimentally determined lift- and moment-curve slopes for a family of delta-wing-body combinations in steady flow. It provides reasonable estimates of the damping in pitch measured on a particular rocket model over a range of supersonic Mach numbers. When applied to a series of possible missile shapes with systematically varied wing planforms, it reveals a strong influence of planform geometry on damping in pitch which cannot be calculated by the conventional slender-body approximation. (Contractor's abstract, modified)

MIT.06:015

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

ON SIMPLE WAVES IN PERFECT AND DISSOCIATING GASES: THEORY AND APPLICATIONS, by H. Kennet. Feb. 1958, 49p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 58-1) (AFOSR-TN-58-302) (AF 18(600)961) AD 154212; PB 143511

Unclassified

A theoretical method is developed for estimating aerodynamic loads on oscillating airfoils in dissociating flow, when the flow is in dissociative equilibrium. This procedure is based on a method of solution originally prepared by Lighthill for the case of a perfect fluid. When the flow is hypersonic, yet real gas effects are negligible, the perfect fluid solution for the prediction of loads on such oscillating airfoils is modified by taking into account the entropy changes at the leading edge. The extension is limited to simple harmonic oscillations with small amplitude-to-airfoil-thickness ratios. It is shown that the changes in the stability derivatives due to the modified theory are small for the thickness ratios and Mach numbers investigated. An extreme case in which real gas effects are not negligible was also investigated.

MIT.07:003

Massachusetts inst. of Tech. Fluid Dynamics Research Group, Cambridge.

AN EXPERIMENTAL STUDY OF THE FLOW FIELD ABOUT SWEEPED AND DELTA WINGS AND SHARP LEADING EDGES, by I. Jaszlics and L. Trilling. Oct.

MIT. 25:001; MIT. 26:001;
MIT. 08:070, 071

1957, 1v. incl. illus. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 57-4) (AFOSR-TR-58-6) (AF 18(600)1306) AD 157948; PB 144067

Unclassified

A series of experiments was performed to define the flow field on the upper surface of high aspect ratio swept wings and narrow delta wings at high angles of attack. It was found that near the root section of either type of wing, the flow is conical. The edge of the vortex sheet which originates at the leading edge is a straight line whose position relative to the leading edge depends only on incidence. On swept wings, the vortex edge turns downstream as soon as the vortex sheet covers the front half of the wing chord, and the flow under the vortex sheet outboard of that turning point is uniform and parallel to the leading edge of the wing. On narrow delta wings the conical symmetry persists almost to the trailing edge.

MIT.25:001

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

AEROELASTIC STABILITY OF LIFTING SURFACES IN HIGH DENSITY FLUIDS, by C. J. Henry, J. Dugundji, and H. Ashley. June 1958, 40p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 58-3) (AFOSR-TN-58-626) (AF 49(638)160) AD 162156; PB 145331

Unclassified

Experimental and theoretical evidence is assembled which suggests that oscillatory aeroelastic instability (flutter) is very unlikely at the structural-to-fluid mass ratios typical of hydrodynamic operation. Flutter data obtained in high-density fluids are reviewed, and various sources of inaccuracy in its theoretical prediction are analyzed. The need is expressed for more precise means of analytically representing both dynamic-elastic systems and three-dimensional unsteady hydrodynamic loads. For a simple hydrofoil with single degrees of freedom in bending and torsion, the theoretical influence of several significant parameters on high-density flutter is calculated and discussed. Recommendations are made for refinements to existing techniques of analysis to include the presence of channel boundaries, free surfaces, cavitation or separated flow.

MIT.26:001

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

GAS DYNAMICS OF FREE MOLECULE FLOW, by A. Toomre. Mar. 1958, 36p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 58-2) (AFOSR-TN-58-787) (AF 49(638)297) AD 202114; PB 144982

Unclassified

The influence of a solid object upon the velocity distribution of gas atoms in free molecule flow is studied. A concept of shadow flow makes it possible to consider two distinct velocity categories, and in principle facilitates the calculation of the velocity distribution function at any point in space. Surface adsorption is considered and a cosine dependence of diffuse reflection is found to be useful. (Contractor's abstract, modified)

MIT.08:070

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

A 50-KMC DIELECTROMETER, by N. E. Dye. Jan. 1957, 21p. incl. illus. diagrs. tables. (Technical rept. no. 114) (Bound with its Technical rept. no. 113; AD 122938) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under [N5ori-07801]) AD 122938(a)

Unclassified

A dielectrometer, using the standing-wave method with circular wave guide, has been developed which permits measurements of the complex permittivity and permeability of materials of 50 kmc. The instrument is capable of measuring relative dielectric constants from 1 to 100 and loss tangents as low as 0.0001. Only small samples are required and measurements can be made over a wide temperature range up to 1200°C. Special developmental problems concerning the crystal detector, slotted section, and probe are discussed in detail. Typical dielectric measurements on various samples are appended. (Contractor's abstract)

MIT.08:071

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

HIGH-TEMPERATURE DIELECTRIC MEASUREMENTS ON RADOME CERAMICS IN THE MICROWAVE REGION, by W. B. Westphal. Jan. 1957, 22p. incl. diagrs. tables. (Technical rept. no. 113) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under [N5ori-07801]) AD 122938

Unclassified

The dielectric constant and loss of certain ceramics have been measured up to peak temperatures ranging from 500° to 1200°C with a view of the possible use of some of them as radome materials. Their characteristics are compared with those of certain glasses and crystals. Two main types of loss appear: conduction loss increasing exponentially with temperature, and absorptions centered in the infrared which prove to be nearly temperature-independent at microwave frequency at temperatures below the softening range. Both losses depend on chemical purity, but quantitative interrelation has not been established. A high purity alumina ceramic

MIT.08:072 - MIT.08:075

having $x^1 = 9.32$ and $\tan \delta = 0.00015$ at 25°C with changes to 10.4 and 0.0011 at 1200°C and 50 kmc proved to be outstanding as a low-loss material. Some special techniques using the standing wave method in shorted waveguides are discussed briefly. (Contractor's abstract)

MIT.08:072

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

INVESTIGATION OF THE FERRITE REGION OF THE PHASE DIAGRAM Fe-Co-O, by J. Smiltens. Jan. 1957, 22p. incl. diagrs. tables. (Technical rept. no. 115) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under [N5ori-07801], and Rome Air Development Center under AF 30(635)2872) AD 123324

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 4881-4884, Sept. 20, 1957.

The cobalto-magnetite phase at 1200°C , in a mixture of 98.13 vol % CO_2 and 1.87 vol % CO, is stable from $X = 0$ to 55.8, where X indicates the atoms of cobalt substituted for iron according to the formula $\text{Co}_x\text{Fe}_{300-x}\text{O}_{400}$.

In pure oxygen the stability interval reaches from $X = 92.8$ to > 120 . At 1400°C , in a mixture of 98.93 vol % CO_2 and 1.07 vol % O_2 , the stability interval extends from $X = 0$ to 94.5, in pure oxygen the lower stability limit was not determined (presumably it lies near $X \approx 70$); the upper limit for X is 113.5. The cobalto-magnetite field in the vicinity of CoFe_2O_4 has no width.

Cobalt does not substitute for iron in the hermatite phase (1200°C). With X initially 100, the melt at 1626°C , in oxygen, has the atomic fraction of oxygen value 0.5611, which is considerably less than that required for the composition CoFe_2O_4 . (Contractor's abstract)

MIT.08:073

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

THE STANDARD FREE ENERGY OF OXIDATION OF MAGNETITE TO HEMATITE AT TEMPERATURES ABOVE 1000°C , by J. Smiltens. Jan. 1957, 14p. incl. diagrs. tables. (Technical rept. no. 116) (Bound with its Technical rept. no. 115) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under [N5ori-07801] and Rome Air Development Center under AF 30(635)2872) AD 123324

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 4877-4880, Sept. 20, 1957.

A correction term is derived for the van't Hoff equation used for calculating the standard free energy from the dissociation pressure data. This term also allows such calculations in cases in which solid solutions are formed. The standard free energy for the reaction $4\text{Fe}_3\text{O}_4 + \text{O}_2 = 6\text{Fe}_2\text{O}_3$ has been calculated. (Contractor's abstract)

MIT.08:074

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

CRYSTAL STRUCTURE REFINEMENT BY LEAST SQUARES WITH THE IBM 650, by L. R. Lavine and J. R. Steinberg. Feb. 1957, 14p. incl. diagrs. tables. (Technical rept. no. 117) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under [N5ori-07801]) AD 125503

Unclassified

A description of a program for performing least-squares refinements of crystal structures is given. Details of subroutines of possible interest to others are included. (Contractor's abstract)

MIT.08:075

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

AN X-RAY METHOD FOR DETERMINING CATION DISTRIBUTION IN FERRITES, by P. Skolnick, S. Kondo, and L. R. Lavine. Feb. 1957, 17p. incl. diagrs. tables, refs. (Technical rept. no. 118) (Bound with its Technical rept. no. 117) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under [N5ori-07801]) AD 125503

Unclassified

Also published in Jour. Appl. Phys., v. 29: 198-203, Feb. 1958.

Cation distribution in many ferrites has been difficult to determine by x-ray diffraction since the scattering factors of such cations as Ni, Co, Mn, and Cu are close to that of Fe. By using radiation of a wave length close to the absorption edge of one of the cations (the ferric ion in this case), sufficient difference in x-ray scattering factors can be developed because of anomalous dispersion, thus allowing the cation distribution to be ascertained. This method was employed in the case of nickel ferrite. Ratios of intensities of the diffracted peaks for $\text{FeK}\alpha$ and $\text{FeK}\beta$ radiation from nickel ferrite was used to eliminate certain factors in the intensity equation which are difficult to calculate, e.g. the absorption and temperature factors. A least-squares technique was used to determine the best values of the cation distribution and the oxygen position for the intensity ratios obtained for seven reflections. It was found that the cation distribution coefficient was 0.48 ± 0.02 , in agreement with

MIT.08:076, 077; MIT.27:001, 002

the results obtained by magnetic-moment measurements and neutron diffraction. The oxygen positional parameter was found to be 0.240 ± 0.002 of the lattice parameter with an octahedral position as the origin. The method appears to be of general value in distinguishing between two elements distributed over nonequivalent positions in a crystal lattice when their x-ray scattering factors are almost equal. (Contractor's abstract)

ization, which arises primarily from the interaction between magnetic ions in the octahedral and tetrahedral lattice sites, is greatly affected by the changes in distribution due to quenching. It is hoped that with an understanding of the basic mechanisms involved in the simpler ferrites, such as magnesium ferrite, some idea of what might be occurring in the more complex combinations of technical importance might evolve.

MIT.08:076

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

INSTRUMENTATION FOR HIGH-FIELD CONDUCTANCE MEASUREMENTS, by F. R. Kotter. [1957] [4]p. incl. illus. diagrs. (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under N5ori-07801 and Army Ordnance) Unclassified

Published in Rev. Scient. Instruments, v. 28: 178-181, Mar. 1957.

Improvements have been made in the differential pulse transformer bridge which increase its inherent precision by approximately an order of magnitude and extend its range to measurements with electrolytes of twenty times the concentration previously feasible. A circuit is described which permits study of the errors introduced by polarization and self-heating when electrolytic conductivity measurements are carried out with rectangular voltage pulses. Also described is equipment for four-terminal resistance measurements with single-voltage pulses, which allows high-field conductance measurements free from errors caused by contact resistance, self-heating, and space-charge accumulation; it has been applied to semiconductors. (Contractor's abstract)

MIT.27:001

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

TABLES OF DIELECTRIC MATERIALS, VOLUME V. Apr. 1957, 267p. incl. diagrs. tables. (Technical rept. no. 119) (Sponsored jointly by Office of Naval Research, Signal Corps and Air Force Office of Scientific Research under Nonr-184110 and Ordnance Materials Research Office) Unclassified

Volume V of this series extends the dielectric data to include high temperatures, ferromagnetics, and attenuator characteristics. The material is presented in both tabular and graphic form. Company and material indexes are included.

MIT.27:002

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

STUDIES ON THE LOWER OXIDES OF TITANIUM, by A. D. Pearson. June 1957, 53p. incl. illus. diagrs. tables, refs. (Technical rept. no. 120) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-184110 and Atomic Energy Commission under AT (30-1)-1937) AD 135252 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 5: 316-327, 1958.

Pure TiO is face-centered cubic (fcc) above ca. 950°C . The structure of samples annealed below this temperature is complex, consisting of 2 or possibly 3 phases not in equilibrium. Impurities and excess of O stabilize the fcc form at room temperature. The electrical resistivity of TiO (prepared by melting) is 2.81×10^{-4} ohm cm at room temperature, and increases with temperature between -162° and 362°C . The thermoelectric emf of TiO is of the same order of magnitude as that of metals. The directly measured density is less than that calculated from the lattice constant, indicating that 14.6% of the lattice positions are unoccupied. The properties of the products suggest that the TiO -phase oxides may be considered as solid solutions of O in Ti. X-ray investigations indicate that Ti_3O_4 probably does not exist. The trigonal unit cell of Ti_2O_3 is confirmed between room

MIT.08:077

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

CONDUCTIVITY AND MAGNETIC HYSTERESIS-LOOP PROPERTIES OF QUENCHED MAGNESIUM FERRITE, by G. Economos. [1957] [5]p. incl. illus. diagrs. tables. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under N5ori-07801) Unclassified

Published in Central Glass and Ceramic Research Inst. Bull. (India), v. 4: 7-11, 1957.

The effect of quenching treatment of magnesium ferrite is critically examined. Magnesium ferrite acquires distributions intermediate between the configurations for "normal" or non-magnetic ferrites and "inverse" ferrites as established by Pauthenet and Bochirol depending upon the temperature of quenching. Magnet-

MIT.27:003 - MIT.27:005

temperature and 350°C by using an improved technique for developing diffraction photographs; at room temperature $a = 5.428\text{\AA}$; $\alpha = 56^\circ 39'$. The lattice parameters change rapidly between 160° and 200°C, corresponding to the rapid increase in magnetic susceptibility. Ti_2O_3 is antiferromagnetic; $\chi_m = 1.09 \times 10^{-6}$ cgs at 30°C.

The thermal activation energy of electric conduction of Ti_2O_3 in the room-temperature region is 0.08 ev, about half of the observed optical activation energy (0.15 ev). The material is a p-type semiconductor at room temperature, but n-type conduction becomes dominant above 240°C. (Contractor's abstract)

MIT.27:003

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

PREPARATION OF THIN SINGLE CRYSTALS OF BARIUM TITANATE, by J. T. Last. [1957] [2]p. (Sponsored jointly by Office of Naval Research, Signal Corps, Air Force [Office of Scientific Research], and Army Ordnance under [Nonr-184110]) Unclassified

Published in Rev. Scient. Instruments, v. 28: 720-721, Sept. 1957.

Etching and handling techniques are described for the preparation of single-crystal samples of BaTiO_3 as thin as 1.5 μ , with an area of about 1 x 2 mm. The samples, supported by a Teflon-silicone tape that had cut-out windows, were etched in H_3PO_4 heated at about the BaTiO_3 Curie temperature at a rate of about 1 μ /min at 130°. Crystal thickness during etching was observed with a low-power microscope. Crystals prepared were sufficiently plane-parallel to permit the observation of interference bands in the near infrared.

MIT.27:004

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

TRANSITION TO THE FERROELECTRIC STATE IN BARIUM TITANATE, by D. Meyerhofer. Oct. 1957, 66p. incl. illus. diagrs. tables, refs. (Technical rept. no. 121) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-184110) AD 148238 Unclassified

Also published in Phys. Rev., v. 112: 413-423, Oct. 15, 1958.

The phase transition in BaTiO_3 at the Curie point was investigated on single crystals with simultaneous optical and electrical measurements. The direction of light propagation and that of the electric field vectors were

at right angles to each other, the orientation being suited for observations of birefringence, domain walls, and phase boundaries in polarized light. Electric polarization and dielectric constant measurements were made, and properties of the crystal were investigated. The resulting data were fitted to a thermodynamic equation developed by Devonshire (Phil. Mag., v. 40: 1040, 1949; v. 42: 1065, 1951; and Advances in Phys., v. 3: 85, 1954). The single crystals were grown by the Remick method (Jour. Amer. Chem. Soc., v. 76: 940, 1954) from KF melt in Pt crucibles. The Curie points of the observed crystals varied between 110° and 120° because of impurities. The transitions to and from the cubic phase were divided into 2 categories. (1) In the slow transition, the new phase nucleates after some time at the edges of the crystal and then slowly grows by domain-wall motion; the temperature hysteresis was small but not zero. (2) In the fast change, the crystal was made to switch uniformly in 1 to 2 μ sec, the time being limited only by the mechanical response time of the crystal as determined by the piezoelectric resonances. (ASTIA abstract)

MIT.27:005

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

OXYGEN IMPURITY IN SILICON SINGLE CRYSTALS, by A. Smakula and J. Kalnajs. Nov. 1957, 12p. incl. diagrs. tables, refs. (Technical rept. no. 122) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-184110) AD 148239 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 6: 46-50, 1958.

Comparison of the lattice constant and density of "pure" silicon crystals and oxygen-contaminated crystals favors the substitutional position of oxygen in the silicon lattice rather than the interstitial. The spectral position and intensities of 15 infrared absorption bands for pure silicon crystals are given. The bands shift slightly toward higher frequency at ca. -130°C but no narrowing was detected. At -130°C the half width of the 1106- cm^{-1} band decreases from 32 to 18 cm^{-1} , the height increases by one third and the maximum shifts to 1120 cm^{-1} . After heat treatment at 1000°C for 48 hr, the intensity of the 1106 cm^{-1} band decreases strongly and three new weak maxima appear at 1065, 1160, and 1230 cm^{-1} . The integrated intensity is lower by only 15 per cent. The above bands coincide with the absorption bands of quartz. This indicates a segregation of SiO and the formation of SiO_2 units. Pure silicon crystals show a higher absorption tail above 1.2 μ , indicating strong strains. (Contractor's abstract)

Massachusetts Inst. of Tech. Lab. for Insulation
Research, Cambridge.

INTERNAL PHOTOEFFECT AND EXCITON DIFFUSION
IN CADMIUM AND ZINC SULFIDES, by M. Balkanski
and R. D. Waldron. Nov. 1957, 43p. incl. diagrs. tables,
refs. (Technical rept. no. 123) (Sponsored jointly by
Office of Naval Research, Signal Corps, and [Air
Force Office of Scientific Research] under Nonr-184110)
AD 149668 Unclassified

Also published in Phys. Rev., v. 112: 123-135, Oct. 1, 1958.

The spectral response of photoconductivity of ZnS and CuS for both single-crystal and sintered-powder samples was measured for several distances between the area of illumination and the electrode region. The energy transport process for indirect illumination was studied by measuring the photocurrent pulses produced by high intensity light flashes and by experiments with light transmission and electric fields. These studies demonstrate energy transport by electrically neutral entities other than photons, which we interpret as diffusion of excitons or mobile-hole pairs. This indirect or transfer photocurrent occurs predominantly at frequencies below the absorption edge of the crystal, with the detailed response being sensitive to the impurity content of the samples. The diffusion parameters in this region generally lie in the following range: lifetime $\tau = 10^{-4}$ to 10^{-6} sec. diffusion constant $D = 10^3$ to 10^4 cm²/sec, and the diffusion length $L = 0.1$ to 1 cm. The transfer photocurrent for steady illumination shows a nearly linear dependence on the incident light intensity. The slow decay of the photocurrent indicates that trapping processes are important in the photocurrent mechanism. Measurement of photocurrent pulses for flash illumination shows a greater than linear dependence on intensity, indicating a second order or bimolecular process. A proposed mechanism for the transfer photoeffect involves initial absorption of the light with creation of an exciton, which diffuses to a trap in the lattice. A second exciton reaching the trap then dissociates, using energy transferred from the trap.

(Contractor's abstract)

**Massachusetts Inst. of Tech. Lab. for Insulation
Research, Cambridge.**

ANSWERS TO SPUTNIK? by A. von Hippel. Dec. 1957, 7p. (Technical rept. no. 124) [Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-184110]
AD 149459 Unclassified

Also published in Bull. Atomic Scientists, v. 14: 115-117, Mar. 1958; Tech. Rev., v. 60: 251, 1958.

The military technology of the present era will not allow the use of traditional methods of discovery and development of materials for weapon use, because of the time lag involved. New substances are required to meet new demands of purity and reliability. There is a need for an interdepartmental "molecular engineering" to design both the materials and the processes used in the production of the materials. This will require full utilization of educational resources both in terms of funds provided and government sponsored research facilities in the universities. Students should be allowed and encouraged to finish scholastic studies, then drafted and permitted to apply for service in the federal research laboratories.

Massachusetts Inst. of Tech. Lab. for Insulation
Research, Cambridge.

**A NEW DETERMINATION OF AVOGADRO'S NUMBER
FROM LATTICE CONSTANT AND DENSITY OF
SINGLE CRYSTALS**, by A. Smakula and J. Kalnajs.
[1957] [7]p. incl. diagr. tables, refs. (Sponsored jointly
by Office of Naval Research, Signal Corps, and Air
Force Office of Scientific Research under Nonr-184110)
Unclassified

Presented at Internat'l Congress on the Fundamental Constants of Phys. and the Forty-second Nat'l Congress of Phys. Turin (Italy), Sept. 6-11, 1956.

Published in Nuovo Cimento, Series X, Suppl., v. 6: 214-220, 1957.

New crystal data are presented for the computation of Avogadro's number. A discussion is given of the separate errors which arise in the values of the crystal data.

The most probable value 6.02368×10^{23} per mole which is obtained is in agreement with values obtained by Birge and those accepted by DuMond and Cohen for use in self consistency calculations of the values of other atomic constants.

Massachusetts Inst. of Tech. Lab. for Insulation
Research, Cambridge.

SPACE-CHARGE BUILD-UP IN POTASSIUM BROMIDE CRYSTALS BY A-C METHODS, by D. K. Donald, Feb. 1958, 22p. incl. diagrs. refs. (Technical rept. no. 125) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-184110) AD 156627 Unclassified

The space theory of von Hippel and others (Phys. Rev., v. 91: 568, 1953) was applied in the determination of the steady state response to an ac voltage and to dc with superimposed ac. The macroscopic implications were employed as a basis for experiments. The ac

MIT.27:010 - MIT.27:013

measurements followed the technique of A. Schmidt (Zeit. Physik, v. 117: 754, 1941). Experiments performed on a series of additively colored crystals indicated that, in spite of anomalous effects, useful ac measurements could be made. All samples showed a space-charge layer across which all or part of the applied voltage appeared. At elevated voltages, field emission set in; further increases in applied voltages developed an even greater fraction of the voltage across the bulk while the voltage across the barrier approached an upper limit. The barrier capacitance measured by transients compared well with that computed from the LF ac data. Samples dried for periods of about 1 wk in a P_2O_5 desiccator had about

1/3 the capacitances of samples promptly inserted into the sample holder after fabrication. Samples held in an evacuated sample holder showed no decrease in measured capacitance for similar periods. None of the samples showed pronounced decreases in photocurrent with age and illumination at room temperatures. (ASTIA abstract)

MIT.27:010

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

TABLES OF DIELECTRIC MATERIALS, VOLUME VI. June 1958, 110p. incl. diagrs. (Technical rept. no. 126) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-184110) AD 200953 Unclassified

Volume VI is the final volume in a series of "Tables of Dielectric Materials". New materials and extended data appear in this supplement to Vols IV and V. Graphic rather than tabular form is used. No new data on ferroelectric materials are presently available but will be the subject of later investigation. Also included are both company and material indexes.

MIT.27:011

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

INTENSITY AND DAMPING DEPENDENCE OF VARIOUS PARAMETERS DESCRIBING SPECTRAL LINE SHAPES, by R. D. Waldron. Sept. 1958, 27p. incl. diagrs. tables. (Technical rept. no. 128) (Sponsored jointly by Office of Naval Research, Signal Corps and Air Force [Office of Scientific Research] under Nonr-184110) AD 204253 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 49: 609-618, June 1959.

Analytical expressions are presented for the frequency dependence of loss factor, conductivity, loss tangent, amplitude attenuation per radian (absorption index),

imaginary refractive index, amplitude and power attenuation per unit length (absorption coefficient), and reflectivity for a damped harmonic oscillator system. Equations are given for the displacement of maxima of these parameters as a function of line strength and width (intensity and damping). Some limiting value relations are given, and the functional dependences of the parameters illustrated graphically. Applications to physical problems are discussed briefly. (Contractor's abstract)

MIT.27:012

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

EVALUATION OF SOME METHODS OF NICKEL FERRITE FORMATION, by G. Economos. Nov. 1958, 23p. incl. diagrs. table. (Technical rept. no. 129) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-184110) AD 208636 Unclassified

The extent of nickel ferrite formation, as affected by four preparatory techniques, was investigated by determining the magnetic moment of the reacted powder with a vibrating-coil magnetometer. The oxide, carbonate, hydroxide and oxalate methods were used. At low temperatures the hydroxide and oxalate techniques were found to give the greatest yield of ferrosphenel. The hydroxide method yields a magnetic material by precipitation. Weight-loss measurements are correlated to the magnetic data. (Contractor's abstract)

MIT.27:013

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

EFFECT OF IRON OXIDE PARTICLE SIZE ON NICKEL FERRITE FORMATION, by G. Economos and T. R. Clevenger, Jr. Nov. 1958, 15p. incl. diagrs. (Technical rept. no. 130) (Bound with its Technical rept. no. 129, AD 208636) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-184110) AD 208636a Unclassified

Five iron oxides of increasing particle-size distribution, mixed with nickel oxide of a constant-size range, were heated at various temperatures and time intervals. The extent of nickel ferrite formation, as influenced by particle size distribution of the iron oxide constituent, was measured with a compensating-coil magnetometer. Using the Jander relationship for this type of reaction, activation energies ranging from 54 to 70 kcal were computed for increasing particle size. These results are examined and compared with current procedures for the production of ferrite powders. (Contractor's abstract)

MIT.27:014 - MIT.27:017

MIT.27:014

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

CURRENT PROBLEMS IN THE PRODUCTION OF MAGNETIC CERAMICS, by G. Economos. Nov. 1958, 7p. incl. diagrs. (Technical rept. no. 131) (Bound with its Technical rept. no. 129. AD 208636) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-184110) AD 208636b Unclassified

Reproducibility of the electrical and magnetic properties while adhering to mechanical tolerances is still the main difficulty in quantity production of magnetic ceramics. This problem is discussed from a developmental viewpoint with suggestions for improving present methods. Older production schemes are compared with newer techniques. (Contractor's abstract)

An extensive series of current-voltage-time characteristics was recorded using cadmium sulfide single crystals with d-c and unidirectional pulse voltages at various temperatures. In addition, transient effects were studied under controlled illumination. While in general the crystals showed a rather high conductivity, which proved essentially independent of temperature in the range from -175° to 100°C, one type exhibited a low conductivity which depended exponentially on temperature. The high-conductivity crystals followed Ohm's law up to a critical point; then a steep current rise and a negative dynamic resistance region were observed. Repeated excitation would generally move this breakover point to a lower voltage. The original conditions could be restored by bulk heating or by a long rest period. The low-conductivity crystals responded similarly to high voltage but space-charge polarization preceded the current rise. The space-charge effect could be neutralized by photoelectric excitation in a relatively short time.

MIT.27:015

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

UNIVERSITIES IN TRANSITION, by A. von Hippel. Dec. 1958, 9p. (Technical rept. no. 132) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-184110) AD 208637 Unclassified

Interdepartmental research centers are recommended as part of a tripartite system along with the university administration and academic departments. These centers should serve as a meeting ground for the various specialists necessary in the development of modern materials required for defense, technology, and for fundamental research. A "Center for Modern Materials Research" could produce both perfect and imperfect materials used in the studies of the properties of materials in order to engineer new materials as required. The centers should be decentralized in the administrative problems and should be held together by the common interest in the problems under study. Both traditional and modern techniques and disciplines should be required as partners in the centers.

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

SOME PROPERTIES OF QUENCHED MAGNESIUM FERRITES, by D. J. Epstein and B. Frackiewicz. [1958] 9p. incl. diagrs. (Technical rept. no. 134) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-184110 and Rome Air Development Center under AF 30(635)2872) AD 209818 Unclassified

Presented at Conf. on Magnetism and Magnetic Materials, Washington, D. C., Nov. 18-21, 1957.

Also published in Jour. Appl. Phys., v. 29: 376-377, Mar. 1958.

A study has been made of the magnetic properties of the system of quenched magnesium ferrites

$(\text{Mg}_x^{\text{II}}\text{Fe}_{1-x}^{\text{III}})(\text{Mg}_{1-x}^{\text{II}}\text{Fe}_{1+x}^{\text{III}})\text{O}_4$, where x , the fraction of

magnesium ions in tetrahedral sites, varies from 0.14 to 0.26. Included among the properties examined are: saturation moment, Curie point, initial permeability and coercive force. A limited study of the kinetics of the cation redistribution has also been made. Samples quenched from 1100°C and then tempered at 600° require somewhat less than 16 hr to attain an equilibrium cation distribution at the latter temperature. The approach to equilibrium is consistent with a model in which the rate of approach is proportional to $\exp(-\theta'_0 + \theta'_1 x)/T$, where

θ'_0 and θ'_1 are activation constants.

MIT.27:016

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

FIELD-STRENGTH EFFECTS IN CADMIUM SULFIDE SINGLE CRYSTALS, by H. Gildea. Dec. 1958, 16p. incl. diagrs. table. (Technical rept. no. 135) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-184110, and Atomic Energy Commission under AT(30-1)1937) AD 209817 Unclassified

MIT.12:146 - MIT.12:148

MIT.12:146

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

PROPOSED COINCIDENCE METHOD FOR THE ELIMINATION OF THE DOPPLER EFFECT, by P. L. Sagalyn. [1956] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and [Air Force] Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at Spectroscopy Symposium, Argonne National Labs., Lemont, Ill., Feb. 15-17, 1956.

Published in Spectrochimica Acta, v. 8: 188, Sept. 1956.

Brannen et al had recently shown that the coincidence rate between pairs of photons, emitted successively by the same atom, can be measured. A method is now devised using coincidence techniques, which in principle enables one to measure the wave-lengths of emission spectra with considerably greater resolution than would be allowed by the Doppler effect. Light from a very weakly excited source is passed through a spectrograph whose resolution is assumed high compared with Doppler width, thereby giving in the focal plane two lines with widths corresponding to the Doppler width. Two slits are used, a fixed reference slit in front of, say, line 1, and a movable scanning slit in front of line 2. Two photomultipliers are used, one behind each slit, and are connected to a coincidence counter through individual channel counters. The true coincidence rate is measured as a function of the position of the movable slit. The momentum of a photon is negligible with respect to that of an atom, and therefore, if the source is operated so that the atom is not perturbed during the lifetime of the intermediate level, the velocity of the atom will not change between the two transitions and the Doppler shifts of the two photons will be the same. The coincidence rate will then show a maximum when the two slits have the same relative positions on the two lines. The width of the response curve will depend on the slit-width and on the resolving power and aperture of the spectrograph, but not on the Doppler width. Estimated counting times for 0.1 Doppler width resolution are of the order of minutes.

MIT.12:147

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

RADIO FREQUENCY EXPERIMENTS IN MERCURY

3P_1 , by P. L. Sagalyn. [1956] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and [Air Force] Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at Spectroscopy Symposium, Argonne National Labs., Lemont, Ill., Feb. 15-17, 1956.

Published in Spectrochimica Acta, v. 8: 188, Sept. 1956.

An apparatus has been constructed for studying radio frequency transitions in the 3P_1 state of the various mercury isotopes. The "double resonance" technique is used. Mercury atoms are excited by polarized light from a mercury arc, containing pure Hg¹⁹⁸, and placed in a magnetic field called the "scanning field." The mercury absorption cell is placed in a steady magnetic field, called the "splitting field," and subjected to an oscillating magnetic field at right angles to the splitting field. The re-emitted light is passed through a suitable polarizer to a photomultiplier and the photomultiplier current is amplified and displayed on a long persistence screen oscilloscope as a function of the splitting field. The splitting field is swept slowly by a low-frequency sinusoidal voltage applied to an auxiliary coil. The deflection of the oscilloscope trace at resonance is the "resonance amplitude." The splitting and scanning-field magnitudes are measured with a nuclear resonance magnetometer. With this apparatus one can study: (1) the g factors of the excited state; (2) if one plots the resonance amplitude as a function of the scanning field, the positions of the maxima provide a new method of measuring isotope shift, which eliminates the effects of overlapping lines whose g-factors differ; (3) at microwave frequencies, the splitting fields required for the odd isotope resonances provide a measurement of the magnetic hyperfine structure interaction. Results for the even isotopes taken at 3100 mc/sec are presented. (Contractor's abstract)

MIT.12:148

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

MICROWAVE MEASUREMENTS OF HIGH ELECTRON

DENSITIES, by S. J. Buchsbaum and S. C. Brown. Jan. 9, 1957 [4]p. incl. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) AD 130566 Unclassified

Presented at the Ninth Annual Gaseous Electronics Conf., Pittsburgh, Pa., Oct. 31-Nov. 3, 1956.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 85, Jan. 30, 1957.

Also published in Phys. Rev., v. 106: 196-199, Apr. 15, 1957.

The conventional microwave method for measuring plasma electron densities is limited in its validity to relatively low concentrations ($\sim 10^9 \text{ cm}^{-3}$). Following a theoretical development by Persson, a method is presented whereby much higher densities can be measured. The method is based on eliminating the effect of ac space

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charge on the probing microwave field. This is accomplished by ensuring that the electric field be everywhere perpendicular to electron-density gradients. A discussion is presented on the effect of neighboring modes on the measuring mode in a microwave cavity. (Contractor's abstract)

MIT.12:149

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OUTLINE OF LEBESGUE THEORY: A HEURISTIC INTRODUCTION, by R. E. Wernikoff. Jan. 11, 1957, 73p. incl. diagrs. refs. (Technical rept. no. 310) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 143098 Unclassified

A heuristic exposition is presented of measure theory and the theory of integration which derives from it. The aim is to acquaint communication engineers with terminology useful in probability and ergodic theories, statistics, and the theory of linear operators in function spaces. The Riemann definition of the integral is reviewed and some of the basic properties of the integral are derived. By means of an example, definite limitations to the class of functions to which the Riemann definition applies are pointed out. In finding an approach which makes these limitations irrelevant, a new point of view is presented which leads to a rudimentary form of Lebesgue's definition of the integral. The measure theory is discussed by answering 2 questions dealing with properties of a set function to make it correspond to the useful ϵ script (E) function, and with the domain over which such a set function can be defined. The integral is rigorously defined and some of its properties are derived. Convergence and limit are defined when a sequence of functions is given instead of a sequence of numbers. Conditions are established under which the order of a limit process and integration may be interchanged; some examples are given. Set functions, absolute continuity, and differentiation are discussed. (ASTIA abstract)

MIT.12:150

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STARK EFFECT ON THE HYPERFINE STRUCTURE OF CESIUM¹³³, by R. D. Haun, Jr. Jan. 18, 1957, 64p. incl. diagrs. tables, refs. (Technical rept. no. 322) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 200290 Unclassified

Also published in *Phys. Rev.*, v. 107: 107-109, July 1, 1957.

The change of the hyperfine-structure separation energy caused by an electric field has been measured in cesium¹³³ by the atomic-beam magnetic-resonance method. The shift of the ($F = 4, m_F = 0$) - ($F = 3, m_F = 0$) transition frequency (9192.6 mc/sec) caused by electric field ξ is given by $\Delta(\xi) = -2.29 \times 10^{-6} (1 \pm .03) \xi^2$ cps, where ξ is in volt/cm. This number is 2.8 times the value predicted from the atomic polarizability measurements of H. Scheffers and J. Stark, if a simplified theory that neglects hyperfine-structure perturbations of the ground-state wave functions is used. A more precise theory which takes into account these wave-function differences has been outlined but the calculations have not been carried out in detail. A means has yet to be developed which will enable the difference between the $F = 4$ and the $F = 3$ wave functions to be taken into account.

MIT.12:151

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

GYRATRON—A NEW SOLID STATE QUANTUM-MECHANICAL AMPLIFIER (Abstract), by M. W. P. Strandberg. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in *Bull. Amer. Phys. Soc.*, Series II, v. 2: 36, Jan. 30, 1957.

Of the several methods of realizing a coherent electromagnetic amplifier using quantum-mechanical energy levels, there is one we choose to call the Gyatron, or "electron spin tool." Some of the possible operating characteristics of such a device will be described. The use of a Gyatron as a thermal amplifier, or as a radio telescope preamplifier, or as a radar or scatter communications preamplifier will be discussed.

MIT.12:152

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

HYPERFINE STRUCTURE AND LINE WIDTH IN F-CENTER SPIN RESONANCE (Abstract), by G. J. Wolga and M. W. P. Strandberg. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 36, Jan. 30, 1957.

The paramagnetic resonance spectrum of F centers in alkali halide single crystals is being investigated at room and low temperatures. Hyperfine structure has been resolved completely in LiF and NaF and partially in NaCl. The observed line widths are interpreted as arising from interaction with surrounding nuclei of the alkali halide lattice. The spacing of the hyperfine lines is interpreted on the basis I-S type of interaction.

MIT.12:153

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

MICROWAVE CONDUCTIVITY MEASUREMENTS IN NEON CONTAMINATED WITH ARGON (Abstract), by A. L. Giliardini. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research [under DA 36-039-sc-64637])
Unclassified

Presented at the Ninth Annual Gaseous Electronics Conf., Pittsburgh, Pa., Oct. 31-Nov. 3, 1956.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 87, Jan. 30, 1957.

The method used by Gould and Brown for determining the electron collision probability for momentum transfer in helium by measuring the microwave conductivity of a decaying plasma as a function of the electron energy, controlled by a microwave heating field, has been used for determining the same parameter in neon. In this case, due to the smaller value of the electron collision probability and the larger atomic mass of neon as compared to helium, energy gradients produced by the heating field nonuniformities are very important in determining an energy redistribution inside the plasma. The conditions required for having a pressure independent ratio of the real to the imaginary part of the complex conductivity and for reaching steady-state electron energy conditions are theoretically investigated. From the measured microwave conductivity in neon contaminated with argon, the electron collision probability in neon has been computed as a function of the electron energy; the curve joins Ramsauer and Kollath's measurements for higher electron energies.

MIT.12:154

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

PLASMA OSCILLATIONS IN DC DISCHARGES (Abstract), by E. I. Gordon. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Presented at the Ninth Annual Gaseous Electronics Conf., Pittsburgh, Pa., Oct. 31-Nov. 3, 1956.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 85-86, Jan. 30, 1957.

A general result for the conductivity of a plasma when the rf field exists in a region not necessarily large compared to a mean free path is shown to be

$$\sigma = -\frac{4\pi}{3} \frac{ne^2}{m} \int_0^\infty [(\omega + \nu_c)^{-1} - (\omega + \nu_c)^{-2} 3\nu/4d] v^3 f(v) dv,$$

where n is the electron density, ω the angular frequency, d the width of the region, $\nu_c(v)$ the collision frequency,

and $f(v)$ is the isotropic velocity distribution. In analogy with Margenau's result, this leads to an effective collision frequency $\nu(v) = \nu_c(v) + 3\nu/4d$, so that the damping

of plasma oscillations is pressure dependent only when the mean free path is comparable to d (order of a mm). It is shown that under conditions satisfied only in the sheath-plasma boundary region, a monoenergetic beam of electrons may have a conductivity whose real part is negative. Consequently, the beam could supply sufficient energy to maintain the oscillations if the beam current density is greater than a minimum value proportional to ω^2 . Results for double beam oscillations are also described and compared with experiment.

MIT.12:155

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

"OFF"-RESPONSES IN THE AUDITORY NERVOUS SYSTEM OF ANESTHETIZED CATS (Abstract), by T. T. Sandel and N. Y.-S. Kiang. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637)
Unclassified

Presented at meeting of the Acoustical Soc. of Amer., Los Angeles, Calif., Nov. 15-17, 1956.

Published in Jour. Acoust. Soc. Amer., v. 29: 184, Jan. 1957.

When acoustic stimuli of duration longer than 0.1 sec are turned off, one frequently records electrical responses at cortical and cochlear locations. Several observations suggest that these "off"-responses are related to acoustic transients. Certain conditions under which cortical off-responses to transients occur have been determined. The stimuli were mostly bursts of tone (about 30 db above threshold) whose frequencies at each location of the recording electrode were specifically not those to which the cortical point was most sensitive. The large "off"-responses obtained are sensitive to decay-time, duration and intensity of the tonal stimulus; they can be masked by noise and they resemble in wave-forms the

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responses evoked by clicks at the same cortical location. When the stimuli were bursts of noise no "off"-responses were observed. These results may be interpreted in terms of the refractory characteristics of groups of neurones. Throughout the period of tonal stimulation, a large proportion of the available cortical neurones is inactive; stimulation with noise, on the other hand, activates many of these neurones. "Off"-responses become detectable when numerous non-refractory cortical neurones are available to fire synchronously. Recordings from cochlear locations support the interpretation.

MIT.12:156

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PITCH JUDGEMENTS FOR REPEATED BURSTS OF TONE AND NOISE (Abstract), by M. H. Goldstein, Jr. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) Unclassified

Presented at the meeting of the Acoustical Soc. of Amer., Los Angeles, Calif., Nov. 15-17, 1956.

Published in Jour. Acoust. Soc. Amer., v. 29: 184, Jan. 1957.

Recently much interest has been shown in the study of pitch judgements for complex auditory stimuli. In the present investigation five subjects were instructed to judge which of a pair of stimuli sounded higher in pitch. One stimulus, the standard, of every pair had a repetition rate of 200/sec; the variable stimulus had a repetition rate that ranged from 175/sec to 225/sec. Within a given pair the stimuli differed thus with respect to modulation rate; the signal to be modulated remained the same. The results of three experiments are reported: in two experiments the stimuli were bursts of 2000 cps tones having different rise times while the third experiment involved bursts of wide-band noise. For repetition rates in the vicinity of 200/sec the difference limen for burst rate is smaller for bursts containing tonal stimuli than for bursts of wide-band noise. These data are discussed in relation to the findings of Miller and Taylor, Small, DeBoer, and Nowbray et al.

MIT.12:157

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

QUANTUM MECHANICAL AMPLIFIERS, by M. W. P. Strandberg. 1957 [2]p. incl. diagr. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) AD 127598 Unclassified

Also published in Proc. Inst. Radio Engineers, v. 45: 92-93, Jan. 1957.

The theoretical aspects of quantum mechanical amplifiers are presented. Recent work on these systems seems to have been restricted to the use of molecular beams and ammonia gas. The operation of a molecular amplifier is based on the principle of creating a nonequilibrium thermodynamic state which can be made to last long enough for net energy to be extracted. The two paramagnetic spin states of either a proton or an electron in a magnetic field are cited as the bases for systems offering marked advantages over the ammonia maser.

First, spin densities 10^5 larger may be achieved, and further, they are simply turnable by means of magnetic field. Other attributes of quantum mechanical amplifiers are considered, such as the possibility they offer of achieving essentially noise-free amplification, and their adaptability to the field of communications.

MIT.12:158

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NEUROPHYSIOLOGICAL REPRESENTATION OF COMPLEX AUDITORY STIMULI, by M. H. Goldstein, Jr. Feb. 19, 1957, 73p. incl. diagrs. refs. (Technical rept. no. 323) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 156530

Unclassified

Neurophysiological representation of complex acoustic signals at the cochlea and cortex of the cat's auditory pathway was investigated. The signals were presented monaurally and included repetitive bursts of noise, clicks, and bursts of tone — signals which human listeners judge to be of low pitch, although the concentration of signal energy is not in the low audio-frequency range. For obtaining characteristic evoked responses from periphery (i.e., cochlea) and cortex, a certain degree of synchrony in the firing of the neural units that contribute to the potentials recorded by gross electrodes is required. By varying the rise time of the envelopes of bursts of noise, cortical responses were evoked for stimuli that did not give rise to the typical N_1 and N_2

spikes at the periphery. The representation of stimulus repetition rate was investigated. Thresholds of cortical responses to transient tonal stimuli vary with the tone frequency, so that tuning curves can be obtained for thresholds of a given cortical point as a function of frequency. Thresholds of cortical responses to repeated bursts of noise were obtained by this technique and were found to be independent of repetition rate. Thresholds could be raised by filtering from the noise the energy in the frequency range to which the point was most sensitive. We conclude that the tonotopic organization of the auditory cortex is related, primarily, to the distribution of stimulus energy in the spectrum. The temporal

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representation of envelope repetition rate was studied for stimuli at low and moderate intensity levels. The synchrony of cortical potentials is difficult to study by visual inspection, since the ongoing activity tends to obscure small evoked responses. By using an electronic processing device that averages a large number of responses we detected synchrony to stimuli, with repetition rates up to 200/sec, in the cortical potentials from unanesthetized cats. In barbiturate-anesthetized cats evoked responses to stimuli, with repetition rates up to 100/sec, were detected. Some psychophysical data on the discrimination of envelope repetition rate of modulated stimuli are also presented. A mathematical representation of signals as a function of two variables—one related to spectral frequency, and the other related to envelope periodicity—is included. (Contractor's abstract)

Also published in Jour. Franklin Inst., v. 263: 213-223, Mar. 1957.

It is possible to compress the classical electromagnetic equations into three complex, four-dimensional quantities \bar{Q} , \bar{I} , and $\bar{\Psi}$. These quantities represent in order electromagnetic fields, currents and charges, and vector and scalar potentials. In addition to the four-dimensional quantities, a complex vector $\bar{Q} = a\bar{E} + jb\bar{B}$ is introduced, where \bar{E} = electric field-strength, \bar{B} = magnetic induction, $j = \sqrt{-1}$, and a and b are real or pure imaginary constants. The components of \bar{Q} represent two related modes, one electric and one magnetic. (Contractor's abstract)

MIT.12:161

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

GRAPHICAL METHOD OF DETERMINING THE EFFICIENCY OF TWO-PORT NETWORKS, by E. F. Bolinder. [1957] [1]p. incl. diags. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Proc. Inst. Radio Engineers, v. 45: 361, Mar. 1957.

A method using graphical constructions is given for determining the efficiency of a two-port network terminated in an arbitrary load.

MIT.12:162

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE VERSITRON - A NEW SOLID-STATE QUANTUM MECHANICAL AMPLIFIER, by M. W. P. Strandberg. [1957] [8]p. incl. illus. diags. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) AD 208703
Unclassified

Also published in Proc. Symposium on The Role of Solid State Phenomena in Electric Circuits, Polytechnic Inst. of Brooklyn, N. Y. (Apr. 23-25, 1957), N. Y., Interscience Publishers, 1957, p. 63-70.

It is suggested that polarized electron spins in solid materials be used with electromagnetic field interactions to get a quantum mechanical amplifier, the Versitron. The Versitron is a device which is magnetically tunable, can be made of any desired bandwidth, and can be operated so that the amplifier has a low effective noise temperature. This low background noise, typically a few

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORY OF FEEDBACK AROUND THE LIMITER, by E. J. Baghdady. [1957] 27p. incl. diags. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Presented at I.R.E. National Convention, New York, Mar. 18-21, 1957.

Published in I.R.E. National Convention Record, Part 8: 176-202, 1957.

A new theory for the effect of feedback around the limiter upon interference rejection in FM receivers considers interference that results from superposition of two carriers differing in amplitude and frequency, and distinguishes between wideband and narrow-band feedback. The theory shows that wideband feedback cannot reduce the magnitude of the frequency spikes caused by the interference, regardless of the feedback angle. Inverse narrow-band feedback aggravates the disturbance and raises the limiting threshold. Positive narrow-band feedback, which causes self-oscillation in the absence of an input signal, results in pronounced capture improvement and automatic noise squelch, and lowers the limiting threshold.

MIT.12:160

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE CLASSICAL ELECTROMAGNETIC EQUATIONS EXPRESSED AS COMPLEX FOUR-DIMENSIONAL QUANTITIES, by E. F. Bolinder. [1957] 11p. incl. illus. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) AD 133273
Unclassified

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degrees K will allow an increase in radar sensitivity and that of scatter communications systems by a factor of nearly 30 db. The design and application of the Versitron is discussed.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

HYPERFINE INTERACTIONS IN F CENTERS (Abstract), by G. J. Wolga and M. W. P. Strandberg. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research [under DA 36-039-sc-64637]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 186, Apr. 25, 1957.

A program of investigation of F centers in alkali-halide crystals under high resolution conditions is described. Use of a very high sensitivity spectrometer capable of detecting 6×10^{-10} spins makes possible the investigation of crystals with low radiation damage. It is to be expected that with minimized radiation damage the hyperfine splitting of the F-center resonance due to both nearest and next nearest neighbor nuclei can be resolved. Data are presented showing such next nearest neighbor splittings in NaF. It is felt that such techniques supply a valuable approach to an understanding of radiation damage in crystals.

MIT.12:164

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

MICROMODULATOR - A DEVICE FOR MEASURING THE INTENSITY OF MICROWAVE ABSORPTION LINES (Abstract), by R. D. Mattuck and M. W. P. Strandberg. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research [under DA 36-039-sc-64637]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 211, Apr. 25, 1957.

An apparatus for determining the absolute intensity of an unknown microwave absorption line up through the K-band region is described. It employs the strong paramagnetic resonance of an organic free radical (di-phenyl trinitrophenyl-hydrazil) as a standard. The radical is placed in a section of wave guide connected in series

with the absorption cell containing the unknown. By varying the applied magnetic field, the free electron resonance may be shifted to any desired frequency. A method of narrowing the standard line for display, by sweeping the magnetic field, is presented. The equations and measurements required are given, together with a discussion of the accuracy of the method.

MIT.12:165

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

SIMPLE TECHNIQUE FOR STUDYING SPIN-LATTICE RELAXATION TIMES (Abstract), by C. F. Davis and M. W. P. Strandberg. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 226, Apr. 25, 1957.

At liquid helium temperatures, spin-lattice relaxation times of paramagnetic salts are frequently as long as milliseconds. Equipment has been built to measure T_1 's from recovery times of crystal x after saturation by a magnetron pulse. Experimental technique and observed T_1 's will be reported.

MIT.12:166

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

TORSION-ROTATION INTERACTION IN SYMMETRIC TOPS (Abstract), by S. Krongelb and M. W. P. Strandberg. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 211, Apr. 25, 1957.

The satellite lines caused by hindered internal rotation have been observed for the $J = 0$ to 1 and $J = 1$ to 2 over-all rotational transitions in methyl silane (CH_3SiH_3). The results have been compared with Kivelson's treatment of the problem, and good agreement found. A variation in dipole moment with internal torsional state is also expected since the hindering barrier

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forces apart the two end groups of the molecule when the internal rotational angle deviates from equilibrium. This variation has been observed and is in agreement with the phenomenological theory.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A STUDY OF ASYNCHRONOUS LOGICAL FEEDBACK NETWORKS, by S. H. Unger. Apr. 26, 1957, 45p. incl. diagrs. refs. (Technical rept. no. 320) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 150502 Unclassified

The systems considered are asynchronous, dc-level, sequential switching circuits; that is, there are no clock pulses, and the signals are represented, not by pulses, but by variables that can assume values in either of two nonoverlapping ranges. The analysis of these circuits is discussed, with emphasis on the problem of choosing state variables. A relationship has been established between the number of rows of a reduced flow matrix and the feedback index of the associated circuit and, furthermore, the need for amplification around each feedback loop has been proved. The major portion of the research is devoted to a study of the effects of stray delays on the operation of sequential switching circuits. By inserting delay elements in all feedback loops, and using hazard-free combinational circuits, correct operation can be obtained despite the stray delays. It has been shown that, for a subset of all sequential functions, delay elements if the possibility of hazards (malfunctioning caused by stray delays) is to be averted, but methods are presented by means of which a single delay element is sufficient for the synthesis of any sequential function. These procedures usually entail more complex circuitry than would otherwise be needed, but several other techniques are presented that may, in certain cases, be useful in minimizing the number of delay elements at a relatively small cost in terms of other components. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AN ANALOG PROBABILITY DENSITY ANALYZER, by H. E. White. Apr. 29, 1957, 28p. incl. illus. diagrs. table, refs. (Technical rept. no. 326) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 156601 Unclassified

The development and construction of an analog analyzer for determining the first-order probability density function of signal amplitudes of frequencies between 30 cps

and 20 kc is described. Values of probability density are determined by averaging a derived random variable that is unity when the signal is in the amplitude interval that is being analyzed and is zero at all other times. It is generated by a diode level-selector circuit that gates a 60-mc carrier to a bandpass amplifier. This level selector eliminates many of the problems of frequency response and drift that are associated with the amplitude discriminators of the conventional level selector. The amplitude range of the signal comprises 50 intervals that are analyzed sequentially and the complete probability density function is plotted by a pen recorder. The frequency response and drift stability of the analyzer are experimentally evaluated, and examples of experimental probability density functions are given. Block diagrams and descriptions of both digital and analog systems that have been previously developed for determining probability density functions are presented. Definitions and some properties of probability density functions are reviewed. (Contractor's abstract)

MIT.12:169

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

IMPEDANCE TRANSFORMATIONS BY EXTENSION OF THE ISOMETRIC CIRCLE METHOD TO THE THREE-DIMENSIONAL HYPERBOLIC SPACE, by E. F. Bolinder. [1957] [13]p. incl. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) Unclassified

Published in Jour. Math. and Physics, v. 36: 49-61, Apr. 1957.

It is shown that for loxodromic transformations, corresponding to impedance transformations through lossy networks, the natural space to which the isometric circle method should be transferred is the three dimensional hyperbolic space which has the Riemann unit sphere as its absolute surface. Two important problems in network theory are studied in this space: (1) analysis or synthesis of a lossy two terminal-pair network from three measurements, and cascading of lossy two terminal-pair networks.

MIT.12:170

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

LATTICE DYNAMICS OF HEXAGONAL CLOSE-PACKED METALS, by L. J. Slutsky and C. W. Garland. [1957] [2]p. incl. diagrs. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

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Published in Jour. Chem. Phys., v. 26: 787-793, Apr. 1957.

The lattice dynamics of hexagonal close-packed metals has been investigated, the assumption being made that the atoms interact with central forces. Atomic force constants are related to the elastic constants by the method of homogeneous deformation in which the contribution of the electron gas to the elastic constants is assumed to arise from an isotropic volume-dependent term in the energy. Relations are given for the propagation of acoustic waves in hexagonal crystals which permit calculation of the elastic constants from ultrasonic pulse velocity measurements. (Contractor's abstract)

MIT.12:171

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A LOGICIAN'S REACTION TO RECENT THEORIZING ON INFORMATION SEARCH SYSTEMS, by Y. Bar-Hillel. [1957] [11]p. Incl. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) AD 139565 unclassified

Also published in Amer. Documentation, v. 8: 103-113, Apr. 1957.

A clear understanding of the distinction between information retrieval systems, the function of which is to make detailed, factual information available, quickly, cheaply, and reliably, and literature search systems, the function of which is to provide a bibliography of documents for the use of the investigator of a specific problem, and of the related distinction between the information-condensing function of the abstract and the clue-providing function of an index, is necessary for progress in information searching. A thoroughly planned interplay of the modern methods of clue-providing by short-phrase index sets with streamlined and mechanizable tracing of leads through cross-references, appears to be definitely superior to any methods of literature searching currently used.

MIT.12:172

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LAW OF MOLECULAR INTERACTION FOR KRYPTON, by M. P. Madan. [1957] [2]p. Incl. table, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Nuovo Cimento, Series X, v. 5: 1369-1370, May 1, 1957.

The force parameters for krypton are evaluated by a thermal diffusion method and are used to calculate the viscosity of krypton at a number of temperatures. Good agreement is obtained with observed viscosity values.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HOT SOURCES FOR MASER, by M. W. P. Strandberg. [1957] [11]p. Incl. illus. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Proc. Eleventh annual Symposium on Frequency Control, Asbury Park, N. J. (May 7-9, 1957), Ft. Monmouth, N. J., Army Signal Engineering Labs., 1957, p. 324-334.

Experimental and theoretical studies have been performed to determine the possibilities of using sources other than NH_3 for MASEP work. Engineering sources are discussed including selectors and cavities. Focusing and state selection have been treated analytically by the calculation of the high field Stark effect for linear rotors and of the relevant trajectories. Results indicate that hot sources can be realized by relatively simple means.

MIT.12:174

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

TRANSIENT CORRECTION BY MEANS OF ALL-PASS NETWORKS, by J. C. Pinson. May 13, 1957, 106p. Incl. diagrs. refs. (Technical rept. no. 324) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 143099 Unclassified

Phase correction, realized in the form of an all-pass network, is frequently used in order to improve the transient response of a system. An investigation is made here to determine the phase correction that should be used to achieve the optimum corrected response for a given system. In general, the ideally desired response cannot be obtained by means of phase correction. Then an error criterion must be used to define the corrected response that best approximates the desired response. The phase correction which gives the corrected response that approximates the desired response with minimum integral square error is determined. For the particular class of systems in which reproduction of the system input is desired, it is found that the correction should linearize the phase of the system in order to produce a corrected response with minimum integral square

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error. Phase correction is most commonly used to enable a system to reproduce better a step function input. It is found that the correction which yields the corrected response with minimum integral square error does not provide the step response with shortest rise time. By consideration of a suitably chosen weighted integral square error criterion, a phase correction is derived which yields a corrected step response with the shortest possible rise time. It is found, however, that the realization of this correction requires an all-pass network with an extremely large number of circuit elements. When correction to reduce the overshoot of the step response of a system is desired, it is found that correction for minimum integral square error provides the optimum response. (Contractor's abstract)

MIT.12:175

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ACTIVE RC NETWORKS, by R. D. Thornton. May 15, 1957 [12]p. incl. diagrs. tables. (Technical rept. no. 334) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 221089
Unclassified

Also published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-4: 78-89, Sept. 1957.

If all available amplifying devices can be approximated by linear models with capacitive, terminal, energy storage, there are bounds on the allowed natural frequencies of circuits constructed from these devices. These bounds are readily determined from the eigenvalues of a frequency matrix and can be related to the maximum power that can be dissipated by the device per unit energy stored in the terminal capacity. Synthesis of unilateral and constant-k amplifiers is considered, and concepts such as the gain-bandwidth product and the maximum frequency of oscillation are related to the bounds on allowed natural frequencies.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

INHERENT NOISE OF QUANTUM-MECHANICAL AMPLIFIERS, by M. W. P. Strandberg. [1957] [4]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Phys. Rev., v. 106: 617-620, May 15, 1957.

The noise figure or limiting sensitivity for both traveling-wave and resonant-cavity quantum-mechanical amplifiers, sensitive to one direction of propagation, is

derived with spontaneous emission as the limiting noise. The concept of effective temperature is introduced as an analytical parameter; thus negative temperatures appear in a natural fashion. It is pointed out that the results of this calculation can be considered the solution to the problem of linear counting of coherent particles. In this case the least count is one and the signal-to-noise ratio (for constant photon flux) increases as the reciprocal of the band width. The limiting temperature sensitivity of properly designed quantum-mechanical amplifiers is given as $h\nu/k$ degrees because of the drastic difference between negative and positive temperatures.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PROPERTIES OF SECOND-ORDER CORRELATION FUNCTIONS, by J. Y. Hayase. May 17, 1957, 65p. incl. diagrs. refs. (Technical rept. no. 330) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 201535
Unclassified

The idea of correlation functions is extended to higher-order correlation functions. A definition of n^{th} -order correlation functions is given, and the general nature of these functions is considered. The emphasis is placed on the case $n = 2$. A survey of the ideas of stochastic process is given, and it is shown how it serves as a model for messages in a communication system. The second-order autocorrelation functions of periodic, aperiodic, and random functions are computed and plotted. Properties of second-order autocorrelation functions concerning continuity, behavior at the origin, phase effects of harmonics, and so forth, are considered. For periodic and aperiodic functions, the relation between first- and second-order autocorrelation functions is given. The Fourier transform of second-order autocorrelation functions is investigated and a physical interpretation of this transform is given. Second-order crosscorrelation techniques are used to determine the location of random noise sources. (Contractor's abstract)

MIT.12:178

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE SPECTRAL EMISSIVITY AND OPTICAL PROPERTIES OF TUNGSTEN, by R. D. Larrabee. May 21, 1957, 81p. incl. illus. diagrs. tables, refs. (Technical rept. no. 328) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 156602
Unclassified

MIT.12:179 - MIT.12:182

An experiment designed to measure the spectral emissivity of tungsten at incandescent temperatures has been initiated. A direct comparison method is utilized in which the radiant intensity from a tungsten source is compared with the radiant intensity from an approximative black body, and the spectral emissivity is computed from the basic relation $E_{\lambda T} = S/B$, where $E_{\lambda T}$ is the spectral emissivity at temperature T and wavelength λ , S is the radiant intensity of the tungsten source, and B is the radiant intensity of the approximative black body. It is shown that the spectral emissivity of tungsten is caused by the classical electromagnetic reflection and refraction of black-body light incident upon the metal-vacuum interface from inside the metal. Equations for the spectral emissivity of tungsten as a function of the direction of polarization and the angle of viewing the tungsten surface are developed in terms of the optical constants of tungsten. The optical constants of tungsten are computed by comparing these equations with the experimental data. An attempt is made to explain the main features of these data in terms of a combination of the Lorentz elastically bound electron theory of insulators and the Drude-Zener-Kronig free-electron theory of metals. (Contractor's abstract)

MIT.12:179

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

BIOLOGICAL COMPUTERS, by W. S. McCulloch. May 1957 [3]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in I.R.E. Trans. on Electronic Computers, v. EC-6: 190-192, Sept. 1957.

This review article describes the similarities between the central nervous system and the electro-mechanical computer devices. The principle function of the central nervous system is seen to be that of a computer for an enormously complex, multiple closed-loop servosystem with more than 10^3 but less than 10^6 distinguishable loops. The function of the reticular formation of the brain stem in the regulation of the firing of the neurons is discussed. The similarity of the parallel coding of the neurons in such a manner to preserve topological relations to the analog computer devices is given. The sequential coding of neurons is believed to have a reliability in distinguishing pulses by interval modulation of about 160 μ sec. At this time there appears to be no detailed understanding of the method of actual coding of information. Several modes of operation of the neuron system are given and it is concluded that the synapse acts as some sort of non-linear filter.

MIT.12:180

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AN EXTENSION OF THE NOISE FIGURE DEFINITION, by H. A. Haus and R. B. Adler. [1957] [2]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) Unclassified

Published in Proc. Inst. Radio Engineers, v. 45: 690-691, May 1957.

Generalized definitions are given for the available gain and noise figure of linear amplifiers which are applicable to those cases involving negative resistances and which reduce to the usual definitions except in those cases in which a negative output occurs somewhere in the cascade. The concept of exchangeable power is introduced in place of the concept available power. An example is given for the noise figure of a cascade of two amplifiers to illustrate the need and the applicability of the new definitions.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MICROWAVE GAS DISCHARGE BREAKDOWN IN AIR, NITROGEN, AND OXYGEN, by D. J. Rose and S. C. Brown. [1957] [3]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) Unclassified

Published in Jour. Appl. Phys., v. 28: 561-563, May 1957.

The microwave breakdown electric field has been measured for pure air uncontaminated by discharge products (presumably oxides of nitrogen), and for nitrogen and oxygen separately. The breakdown field for pure air is significantly higher than that previously observed, in which cases such contamination could be suspected. The breakdown field for pure air lies between those for nitrogen and oxygen. A calculation of the high-frequency breakdown field in air is made from dc data, using the measured Townsend ionization coefficient, electron attachment coefficient, and average electron energy. The present data agree well with this calculation. (Contractor's abstract)

MIT.12:182

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DETERMINATION OF THE COEFFICIENT OF DIFFUSION AND FREQUENCY OF IONIZATION IN MICRO-WAVE DISCHARGES, by M. P. Madan, E. I. Gordon and

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others. [1957] [5]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Phys. Rev., v. 106: 839-843, June 1, 1957.

A method is presented for direct determination of the frequency of ionization and of the coefficient of free diffusion for electrons in a microwave discharge. The method is based on determining the rate of growth of the electron density in a microwave cavity in which an electric field larger than that necessary for breakdown is applied. The ionization frequency and the coefficient of free diffusion for electrons in hydrogen were measured in a pressure range of 15 to 45 mm Hg. Comparison is made with existing theory. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HIGH-FREQUENCY GAS-DISCHARGE BREAKDOWN IN THE PRESENCE OF MAGNETIC FIELDS, by S. C. Brown. [1957] [11]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]; and Atomic Energy Commission under (AT(30-1)1842))
Unclassified

Published in Proc. Third Internat'l. Congress on Ionization Phenomena in Gases, Venice (Italy), (June 11-15, 1957), Milan, 1957, p. 169-179.

The principal modifications of the a-c gas discharge breakdown are summarized when a magnetic field is superimposed on the discharge tube. The controlling mechanisms considered are diffusion, oscillation-amplitude limit, mean-free-path limit, electron-resonance breakdown, and E-B containment.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PROPERTIES OF THE PLASMA DETERMINED BY LANGMUIR PROBE MEASUREMENTS IN LOW-PRESSURE MERCURY ARCS, by W. B. Nottingham. [1957] [28]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Proc. Third Internat'l. Congress on Ionization Phenomena in Gases, Venice (Italy) (June 11-15, 1957), Milan, 1957, p. 756-783.

New methods are shown for the analysis of Langmuir probe data. Not only have the methods been explained, but the results are illustrated by relating the equations to the best experimental data available at present. The efficiency of the process by which excited atoms of Hg are converted into positive ions is discussed. It is proposed that this high efficiency results from the formation of an excited Hg molecule which is then ionized and dissociated.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

IMPEDANCE AND POWER TRANSFORMATIONS BY THE ISOMETRIC CIRCLE METHOD AND NON-EUCLIDEAN HYPERBOLIC GEOMETRY, by E. F. Bolinder. June 14, 1957, 96p. incl. diagrs. refs. (Technical rept. no. 312) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 708704
Unclassified

An introductory investigation on the means by which modern (higher) geometry can be used for solving microwave problems is presented. It is based on the use of an elementary inversion method for the linear fractional transformation, called the "isometric circle method," and on the use of models of non-Euclidean hyperbolic geometry. After a description of the isometric circle method, the method is applied to numerous examples of impedance and reflection-coefficient transformations through bilateral two-port networks. The method is then transferred to, and generalized in, the Cayley-Klein model of two-dimensional hyperbolic space, the "Cayley-Klein diagram," for impedance transformations through lossless two-port networks. A similar transfer and generalization is performed in the Cayley-Klein model of three-dimensional hyperbolic space for impedance transformations through lossy two-port networks. In the Cayley-Klein models a bilateral two-port network is geometrically represented by a configuration consisting of an "inner axis" and two non-Euclidean perpendiculars to the inner axis. The position of the configuration in the models depends upon the fixed points and the multiplier of the linear fractional transformation. By using this geometric representation, an impedance transformation through a bilateral two-port network is performed by consecutive non-Euclidean reflections in the two perpendiculars. The Cayley-Klein model of three-dimensional hyperbolic space is used: (a) for creating a general method of analyzing bilateral two-port networks from three arbitrary impedance or reflection-coefficient measurements; (b) for creating a general method of cascading bilateral two-port networks by "the Schilling figure"; (c) for determining the efficiency of bilateral two-port networks; (d) for classifying two-port networks; (e) for splitting a two-port network into resistive and reactive parts; and (f) for comparing the iterative impedance method and the image impedance method. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CORTICAL RESPONSES TO REPEATED CLICKS AND BURSTS OF NOISE (Abstract), by M. H. Goldstein, Jr. and N. Y-S. Kiang. [1957] [14p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., New York, May 23-25, 1957.

Published in Jour. Acoust. Soc. Amer., v. 29: 773, June 1957.

Synchronous neural activity has been recorded by gross electrodes from the auditory nerve in response to repeated impulsive stimuli at rates up to 2000/sec. However, cortical activity, recorded by gross electrodes exhibits no directly identifiable stimulus-locked responses at rates as low as 100/sec. For rates higher than 5/sec the amplitude of cortical responses to repeated stimuli decreases. Overlapping of and interference between successive responses as well as a lack of synchrony contribute to the reduction in size of the cortical responses. Gross electrodes were placed on and in the auditory cortex of cats and steady-state responses recorded to repeated clicks, bursts of noise, and bursts of tone. Stimuli were delivered at intensity levels at which the auditory system is clearly mechanically linear. Responses from both anesthetized and unanesthetized preparations were recorded on magnetic tape and processed by a special analog computer in order to obtain the characteristics of the average response. This method permits the detection of small responses in the presence of large ongoing activity. In unanesthetized preparations synchronous cortical responses were found at rates up to 200/sec.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

HIGH-FIELD STARK EFFECT IN LINEAR ROTORS, by M. Peter and M. W. P. Strandberg. [1957] [3]p. incl. diagr. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Jour. Chem. Physics, v. 26: 1657-1659, June 1957.

Stationary perturbation theory has been used to calculate the Stark effect in the linear rigid rotor for the case in which the electric energy is large compared with the rotational energy. The method has been checked against

the exact energy values, which were calculated for this purpose. Extension of the method to the Stark effect in the general rotor is possible. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SMALL SIGNAL POWER THEOREM FOR ELECTRON BEAMS, by H. A. Haus and D. L. Bobroff. Nov. 19, 1956 [11]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Jour. Appl. Phys., v. 28: 694-704, June 1957.

An analysis is presented of a filament beam in arbitrary dc electric and magnetic fields. The trajectory of the filament beam in the absence of ac fields may thus follow an arbitrary curve. It is shown that the electromagnetic power delivered by the filament beam is, within the assumptions of small signal theory, balanced by a decrease in the beam of a quantity, the "generalized ac power" in the beam. This ac power involves products of the small signal beam-excitation amplitudes. The ac power theorem for a filament beam can be extended to a thick beam. This is done to find the small signal ac power theorem for a two-dimensional rectilinear beam of finite thickness. The power theorem presented here is applicable to M-type and E-type traveling-wave devices. Applications to the noise theory and signal analysis of electron beams are indicated. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ANALYSIS OF CIRCUITS WITH MULTIPLE-HOLE MAGNETIC CORES, by L. S. Onyshkevych. July 9, 1957, 63p. incl. illus. (Technical rept no 329) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 214554 Unclassified

Multiple-hole magnetic cores, also called transfluxors, which have been developed recently, promise to be very useful in computer, control, and other logical circuitry. They are ferrite cores, with square hysteresis loops, of various complicated geometries. A workable analysis procedure for circuits that contain transfluxors is developed; it is based on the square-wave-shape approximation. This analysis forms a basis for a design procedure. Sample circuits were designed and tested, and the results were found to be within 10% of the predicted values. The main problems in circuit design were flux division and loading effects. Diode elimination presented

another problem, which is treated at some length. Diodeless operation of a transfluxor circuit was found to be possible, but slow, unreliable, and critical. In the field of logical design, a symbolic notation was developed, and an approach to design was density using "gate boxes." A description of the physical properties of transfluxors is given; it includes some new special effects encountered with multiple-hole cores. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORY OF LOW-DISTORTION TRANSMISSION OF FM SIGNALS THROUGH LINEAR SYSTEMS, by E. J. Baghdady. July 30, 1957, 48p. incl. diagrs. tables, refs. (Technical rept. no. 332) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 201536 Unclassified

The convergence properties of the Carson and Fry and of the Van der Pol-Stumpers expansions for the complex amplitude of the steady-state response of a filter to an FM excitation are discussed. The theory of quasi-stationary analysis and of FM-to-AM conversion with low distortion is presented. The use of Taylor's formula leads to error estimates and to a simple condition that specifies an upper bound on the error incurred in restricting the solution to the quasi-stationary term (the instantaneous-frequency method). A sluggishness ratio and an index of stiffness are defined for filters whose system functions have poles only in the upper left half-plane. Sluggishness ratios and indices are given for various filters of wide practical interest. The results indicate that filter band-widths must be prescribed on the basis of the fastest rate at which the instantaneous frequency of the excitation is swept. Applications to sinusoidal modulation and to two-path interference that emphasize the limitations of specifying filter bandwidths on the sole basis of frequency deviation are offered. Applications to the reproduction of FM video waveforms are discussed. The discussion concludes with an analysis of harmonic and intermodulation distortion in the quasi-stationary response. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

POTENTIAL PARAMETERS FOR KRYPTON, by M. E. Madan. [1957] [3]p. diagrs. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Jour. Chem. Physics, v. 26: 113-115, July 1957.

Thermal diffusion in krypton has been used in conjunction with thermal conductivity to obtain the intermolecular force parameters of modified Buckingham Exp: 6 potential energy function. Experimental data have been reduced and smoothed by using a method described in a previous paper. The accuracy of force parameters have been tested by calculating values of the coefficient of self-diffusion and viscosity at different temperatures and comparing the results with experimental data. Satisfactory agreement was found. (Contractor's abstract)

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[Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.]

SOME APPLICATIONS OF THE ISOMETRIC CIRCLE METHOD TO IMPEDANCE TRANSFORMATIONS THROUGH LOSSLESS TWO-PORT NETWORKS (Abstract), by E. F. Bolinder. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 22-25, 1957.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-5: 331, July 1957.

The isometric circle method is a graphical method of transforming a complex quantity by the linear fractional transformation. If the quantity is a complex impedance Z , then the linear fractional transformation

$$\frac{Z' - aZ + b}{cZ + d'} \quad ad - bc = 1 \quad (1)$$

can be interpreted as an impedance transformation through a bilateral two-port network which, for a fixed frequency, is characterized by the four complex constants a , b , c , and d . The isometric circle is defined as the circle which is the complete locus of points in the neighborhood of which lengths are unaltered in magnitude by (1). The isometric circle of the direct transformation, C_d , has its center at $O_d = -d/c$ and a radius $R_c = 1/c$; the isometric circle of the inverse transformation, C_i , has its center at $O_i = a/c$ and the same radius. Mathematically, (1) is divided into two classes of transformations: the loxodromic transformation, characterized by $a + d = \text{complex}$, and the nonloxodromic transformation, characterized by $a + d = \text{real}$. The latter transformation is further divided into the hyperbolic, parabolic, and elliptic transformations specified by $a + d > 2$. If the two isometric circles are drawn in the complex plane,

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the following graphical constructions yield a graphical method for the loxodromic case: (1) an inversion in the isometric circle of the direct transformation C_d ; (2) a reflection in the symmetry line L to the two circles; and (3) a rotation around the center O_1 of the isometric circle of the inverse transformation through an angle $-2 \arg(a + d)$. If the bilateral two-port network is lossless, it is shown that the impedance transformation corresponds to a nonloxodromic transformation. In this case the third operation above is eliminated. A plotting of the isometric circles immediately specifies the nonloxodromic transformation. If the two circles intersect, the elliptic, above-cutoff, case exists; if the circles are tangent the parabolic, cutoff, case exists; and, finally, if the two circles are external the hyperbolic, below-cutoff, case exists. The isometric circle method is applied to impedance and reflection coefficient transformations through some simple bilateral, lossless, two-port networks. The examples chosen are: a uniform transmission line, a lossless transformer, an exponentially tapered transmission line, and uniform waveguide sections (TE and TM modes). Graphical constructions for simple numerical examples are shown both in the impedance plane and the reflection coefficient plane (Smith chart). The connections between the constructions in the two planes are shown by mapping the planes stereographically on the unit sphere. It is shown that the transformation through the uniform transmission line is elliptic and that it corresponds to a rotation of the sphere around a line through the fixed points. The ideal transformer, on the other hand, is hyperbolic and corresponds to a stretching of the surface of the sphere along a line through the fixed points. Finally, the exponentially tapered line and the waveguide section may both be elliptic, parabolic, or hyperbolic depending on simple relations between the mechanical dimensions and the frequency.

MIT.12:193

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SEQUENTIAL DECODING FOR RELIABLE COMMUNICATION, by J. M. Wozencraft. Aug. 9, 1957, 1v. incl. diagrs. refs. (Technical rept. no. 325) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 145016

Unclassified

Shannon's coding theorem for noisy channels states that it is possible to communicate information, with arbitrarily small error, at any rate of transmission less than the channel capacity. The attainable probability of error has previously been bounded as a function of capacity, transmission rate, and delay. This investigation considers the behavior of a new parameter, the average number of decoding computations. A convolutional encoding and sequential decoding procedure is proposed for the particular case of the binary sym-

metric channel. With this procedure, the average number of decoding computations per information digit can be constrained to grow less rapidly than the square of the delay. The decoding process converges for constant rates of transmission that are not too close to capacity. Although it has not been possible to prove this rigorously, it appears that the probability of error decreases exponentially with delay, and is essentially optimum for transmission rates near the limit of convergence. It also appears that the sequential decoding technique can be extended to more general channels. (Contractor's abstract)

MIT.12:194

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELASTIC CONSTANTS OF MAGNESIUM FROM 4.2°K TO 300°K, by L. J. Slutsky and C. W. Garland. [1957] [5]p. incl. diagrs. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 214, Apr. 25, 1957.

Published in Phys. Rev., v. 107: 972-976, Aug. 15, 1957.

The adiabatic elastic constants of magnesium single crystals have been measured by an ultrasonic pulse technique. The values at 298°K are in good agreement with the recent values of Long and Smith. The values extrapolated to 0°K are $c_{11} = 0.635$, $c_{33} = 0.664$, $c_{44} = 0.1842$, $c_{12} = 0.259$, $c_{13} = 0.217$ in units of 10^{12} dynes/cm². A Debye characteristic temperature, θ , of $388 \pm 3^\circ\text{K}$ has been calculated at 0°K by averaging the inverse cube of the longitudinal and transverse wave velocities over all directions of propagation. Atomic force constants for a central-force model with an electron gas term are also obtained. (Contractor's abstract)

MIT.12:195

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE DESIGN AND OPTIMIZATION OF SYNCHRONOUS DEMODULATORS, by R. C. Booton, Jr. and M. H. Goldstein, Jr. [1957] [17]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])

Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 20-23, 1957.

MIT.12:196 - MIT.12:199

Published in I.R.E. WESCON Convention Record, Pt. 2: 154-170, 1957.

Suppressed-carrier modulation involves multiplication of a sinusoidal carrier by a message signal. Synchronous demodulation is the recovery of the message signal by means of a time-varying circuit the parameters of which are varied periodically at the carrier frequency. It is shown that the operation of most practical demodulators can be represented by two cascaded operations, multiplication by a periodic function followed by a time-invariant filter. The effects of message bandwidth and disturbances, such as noise and quadrature, are analyzed for basic practical demodulators. The optimization theory for time-varying linear systems is applied to the demodulation problem. The minimum mean-square error is calculated numerically and compared with the results obtained for practical demodulators. (Contractor's abstract)

MIT.12:196

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORETICAL AND EXPERIMENTAL STUDY OF MOLECULAR-BEAM MICROWAVE SPECTROSCOPY, by M. Peter and M. W. P. Strandberg. Aug. 26, 1957, 50p. incl. illus. diagrs. tables, refs. (Technical rept. no. 336) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 200421

Unclassified

A variety of topics that bear directly upon the use of molecular-beam spectroscopic methods for precise frequency determination with the use of alkali-halide molecules are discussed. The rotational-energy spectrum, including resolvable hyperfine structure arising from quadrupole and magnetic interactions, is calculated. An analysis of integrated line strength, or intensities, is presented. State selection is discussed in terms of the appropriate high-field Stark effect, for which new calculations are given. State selection with both axial and transverse-rod configurations is discussed and trajectories for sodium chloride with the use of a transverse-rod state selector are indicated. The limitations of any state selector which arise from nonadiabatic losses are analyzed. The design parameters of a microwave spectroscopy, including signal-to-noise ratio and ultimate precision, are related to its geometric configuration, and a description of an apparatus that is adequate for high-resolution work is given. Related topics, such as the concept of efficiency of frequency measurements and frequency pulling, are discussed in generalized fashion. Conclusions that can be derived from this work, as to both present limitations and necessary future development, are drawn. (Contractor's abstract)

MIT.12:197

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MEASUREMENT OF PARAMAGNETIC SPIN LATTICE RELAXATION TIMES WITH PULSE TECHNIQUES, by M. W. P. Strandberg, C. F. Davis, and R. L. Kyhl. [1957] [4]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) Unclassified

Published in Proc. Fifth International Conference on Low Temperature Phys. and Chem., Madison, Wis. (Aug. 26-31, 1957), Madison, Univ. of Wisconsin Press, 1958, p. 534-537.

Paramagnetic relaxation measurements have been made by a new technique in an attempt to answer some of the fundamental questions of relaxation phenomena. By using a low average power, a relatively long relaxation time could be measured that exhibited, predominantly, the characteristics of the spin lattice relaxation step.

MIT.12:198

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

COMPUTATION OF NOISE FIGURE FOR QUANTUM-MECHANICAL AMPLIFIERS, by M. W. P. Strandberg. [1957] [2]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Phys. Rev., v. 107: 1483-1484, Sept. 15, 1957.

An expression is derived for the noise figure for a quantum-mechanical amplifier in terms of the physical quantities describing the electromagnetic structure and the paramagnetic salts - such as gain, circuit Q's, and salt molecular weight and volume. (Contractor's abstract)

MIT.12:199

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THERMIONIC EMISSION FROM A PLANAR TANTALUM CRYSTAL, by H. Shelton. [1957] [5]p. incl. diagrs. (Technical rept. no. 327) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) AD 217595 Unclassified

Also published in Phys. Rev., v. 107: 1553-1557, Sept. 15, 1957.

MIT.12:200 - MIT.12:202

Two (211) crystals in tantalum ribbon are used as emitter and collector in a three-element retarding-potential experiment. The electrons from one crystal are accelerated through a small aperture which, in conjunction with a strong axial magnetic field, collimates a beam and directs it to the collector crystal. The uniform work-function of single crystals, plane geometry, and the collimating magnetic field completely remove the deleterious effects of conventional retarding-potential experiments that prevent the exact determination of the energy distribution. The resulting retarding-potential plot indicates close agreement with the theoretically predicted two intersecting straight lines on semi-logarithmic paper, with the transition region extending less than 20 mv. This indicates a Maxwellian distribution with no large energy-dependent reflection. The temperature, the saturated current density, and the temperature derivative of the work-function, as found from different retarding-potential plots, are used in a Richardson analysis to derive the thermionic constants. (Contractor's abstract)

MIT.12:200

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LIST DECODING FOR NOISY CHANNELS, by P. Elias. Sept. 20, 1957 [11]p. incl. diagrs. refs. (Technical rept. no. 335) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 216194

Unclassified

Published in I.R.E. WESCON Convention Record, Pt. 2: 94-104, 1957.

Shannon's fundamental coding theorem for noisy channels states that such a channel has a capacity C , and that for any transmission rate R less than C it is possible for the receiver to use a received sequence of n symbols to select one of the 2^{nR} possible transmitted sequences, with an error probability P_e which can be made arbitrarily small by increasing n , keeping R and C fixed. Recently upper and lower bounds have been found for the best obtainable P_e as a function of C , R , and n . This paper investigates this relationship for a modified decoding procedure, in which the receiver lists L messages, rather than one, after reception. In this case for given C and R , it is possible to choose L large enough so that the ratio of upper and lower bounds to the error probability is arbitrarily near to 1 for all large n . This implies that for large L , the average of all codes is almost as good as the best code, and in fact that almost all codes are almost as good as the best code. (Contractor's abstract)

MIT.12:201

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ABOUT SUCH THINGS AS UNISTORS, FLOW GRAPHS, PROBABILITY, PARTIAL FACTORING, AND MATRICES, by S. J. Mason. [1957] [8]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-4: 90-97, Sept. 1957.

The purpose of this paper is to point out three things. (1) Topological circuit analysis, in which one looks for trees, and topological flow-graph analysis, in which one looks for loops, are intimately related, since both have to do with simultaneous, linear algebraic equations. The intimate relationship becomes an identity when one deals with Markoff probability diagrams, for which the circuit model of the problem and the flow-graph model of the problem are one and the same. (2) The expression for a flow-graph transmission in terms of the branch transmissions can often be made much more compact by a process called partial factoring. Fortunately, this process has a simple topological interpretation, so that the compact form is obtainable by inspection of the flow graph. (3) Simultaneous linear matrix equations may be conveniently expressed in flow-graph form, whereupon the solution is obtainable by standard flow-graph reduction techniques.

MIT.12:202

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SURVEY OF SOME PROPERTIES OF LINEAR NETWORKS, by E. F. Bolinder. [1957] [9]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA-36-039-sc-64637]) Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-4: 70-78, Sept. 1957.

A brief exposé is given of some recent works on linear network properties. The concepts treated are the following: passivity, stability, efficiency, and non-reciprocity; n -terminal-pair networks and two-terminal-pair networks in particular are studied at a fixed frequency.

MIT.12:203 - MIT.12:207

MIT.12:203

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

COMMENT ON THE ROTHEN PHOTOELECTRIC
ELLIPSOMETER, by R. D. Mattuck. [1957] [1]p. (Spon-
sored jointly by Signal Corps, Office of Naval Research,
and Air Force Office of Scientific Research under
[DA 36-039-sc-64637]) Unclassified

Published in Rev. Scient. Instruments, v. 28: 844,
Oct. 1957.

Precision measurements of the thickness of nonab-
sorbing films may be obtained with the Rothen photo-
electric ellipsometer. The author points out that while
this may be true for films which may be built up to thick-
nesses of greater than ~300A, it is not true for films
restricted to the 0-300-A region (such as adsorbed
protein films). A summary of this report is included
and contains the following information: (1) For a
precise determination of film thickness, d , by the
Rothen method, one requires knowledge of the film
index n ; (2) For films which cannot be built up to thick-
nesses > 300A one cannot obtain n by the Rothen tech-
nique or any other standard procedure; and (3) There-
fore, the Rothen method is incapable of providing a pre-
cise determination of film thickness for films restricted
to the range 0-300A. The author mentions in his con-
clusion that a simple way exists in which the photoelec-
tric ellipsometer may be modified to allow simultaneous
measurement of thickness and refractive index of films
10A to 250A. This method employs a stepped barium
stearate interference reflector and white light interfer-
ence fringes.

MIT.12:204

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

NOISY AND NOISE-FREE TWO-PORT NETWORKS
TREATED BY THE ISOMETRIC CIRCLE METHOD, by
E. F. Bolinder. [1957] [2]p. incl. diagr. (Sponsored
jointly by Signal Corps, Office of Naval Research, and
Air Force Office of Scientific Research under [DA 36-
039-sc-64637]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 45: 1412-
1413, Oct. 1957.

A short outline is presented of the method of treating
two-port networks by means of a linear fractional trans-
formation of the complex impedance of the network.
The relationship of the graphical and analytical treat-
ments is presented.

MIT.12:205

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

NUCLEAR RESONANCE SPECTRA OF RAPIDLY INTER-
CONVERTING ROTATIONAL ISOMERS, by D. M.
Graham and J. S. Waugh. [1957] [2]p. incl. diagrs.
(Sponsored jointly by Signal Corps, Office of Naval Re-
search, and Air Force Office of Scientific Research un-
der [DA 36-039-sc-64637]) Unclassified

Published in Jour. Chem. Phys., v. 27: 968-969, Oct.
1957.

Small splittings δ in the proton resonance spectra of
ethane-like molecules are shown to arise from rotational
isomerism. This is supported by measurements of the
temperature dependence of δ , which decreases with
increasing temperature.

MIT.12:206

Massachusetts Inst. of Tech. [Research Lab. of
Electronics] Cambridge.

ATOMIC FREQUENCY STANDARDS, by J. R. Zacharias.
[1957] [2]p. [Sponsored jointly by Signal Corps, Office
of Naval Research, and Air Force Office of Scientific
Research under DA 36-039-sc-64637] Unclassified

Published in Proc. Conf. on Radio and Microwave Spec-
troscopy, Duke U., Durham, N. C. (Nov. 4-6, 1957),
Washington, Office of Naval Research [1957] p. 67-68.

An experiment has been underway for several years at
MIT to try to observe atomic cesium under free fall for
time intervals of a second or two (the purpose in mind
being to prepare an atomic cesium beam frequency
standard for observing the gravitational red shift

$(10^{-15}/\text{mile})$. The experiment has been unsuccessful,
and it has finally been abandoned. The reasons for this
are discussed in this brief account.

MIT.12:207

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

COMPUTER TECHNIQUES FOR THE STUDY OF PAT-
TERNS IN THE ELECTROENCEPHALOGRAM, by
B. G. Farley, L. S. Frishkoph and others. Nov. 6, 1957,
19p. incl. illus. (Technical rept. no. 337; Lincoln Lab.
Technical rept. no. 165) (Sponsored jointly by Signal
Corps, Office of Naval Research, and Air Force Office
of Scientific Research under [DA 36-039-sc-64637])
AD 110027 Unclassified

A process has been explored, using the Lincoln TX-O

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computer, for detecting patterns in the electroencephalogram and for recognizing the characteristics of the EEG corresponding to individual subjects. Preliminary results indicate that a number of different subjects and states of the same subject can be distinguished with excellent probability. (Contractor's abstract)

MIT.12:208

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CHEMICAL SHIFTS IN $C_5H_5^-$ AND $C_7H_7^+$ IONS: THE FREE ELECTRON MODEL, by J. R. Leto, F. A. Cotton, and J. S. Waugh. [1957] [2]p. incl. table. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Nature, v. 180: 978-979, Nov. 9, 1957.

Data are presented on the aromatic systems cyclopentadienide ion, $C_5H_5^-$, and tropylium ion, $C_7H_7^+$.

NaC_5H_5 in tetrahydrofuran was prepared from Na sand and freshly distilled tetrahydrofuran. Tropylium bromide was prepared by the method of Doering and Knox from tropyliene, a product of the isomerization of bicyclo [2.2.1] hepta-2,5-diene. The proton resonance spectra were observed on a high-resolution spectrometer and extrapolated to infinite dilution in aqueous solutions for $C_5H_5^-$ and in both aqueous and methanol solutions for $C_7H_7^+$.

Although agreeing in sign, observed differences were much more extreme than calculated ones. It was concluded that, besides the effect of free electrons, other contributing factors exist which have to do with differences in electron density at the protons.

MIT.12:209

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DETECTION OF BEATS IN REPEATED BURSTS OF TONE (Abstract), by M. H. Goldstein, Jr. and T. T. Sandel. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Michigan U., Ann Arbor, Oct. 24-26, 1957.

Published in Jour. Acoust. Soc. Amer., v. 29: 1257, Nov. 1957.

Listeners report hearing beats in repeated bursts of

tone of low intensity provided the burst rate stands in a nearly harmonic relation to the frequency of the tone and provided that certain conditions of rise time of the bursts and frequency of the tone (carrier) are met. A typical signal that will give rise to beats at a rate of 2/sec might be one in which bursts of a tone of 2001 cps are repeated at a rate of 200 per second; the bursts of tone are presented at a level of 35 db above threshold with a rise time of 0.25 msec for each burst, and a sound-time fraction of 0.5. In these experiments, listeners were asked to report the presence or absence of beats as the frequency of the carrier was slowly changed. For a given test, repetition rate, sound-time fraction, and rise time were held constant. For a nearly harmonic situation the probability of detection of beats is greater for short rise times, and carriers of relatively low frequency. Data on the masking of the beats with wide-band noise, high-pass filtered noise, and low-pass filtered noise are also presented. These experiments permit comparison of various mathematical representations of these stimuli with respect to their ability to predict the listeners responses.

MIT.12:210

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELECTRICAL RESPONSES OF THE AUDITORY SYSTEM TO DIFFERENT TYPES OF TRANSIENT STIMULI (Abstract), by E. de Boer. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Michigan U., Ann Arbor, Oct. 24-26, 1957.

Published in Jour. Acoust. Soc. Amer., v. 29: 1249, Nov. 1957.

In physiological experiments on the cat's auditory system clicks have often been used because of their ability to produce synchronized neural firings. In this study the class of impulsive stimuli has been extended. The electrical signals fed to the earphone are close approximations to members of the family of singularity functions. In the present experiments doublets, impulses, step, and ramp functions have been used. Each of these functions is the time integral of the previous one, with a conversion factor involving the time dimension. The actual wave form of the acoustic stimulus at the animal's eardrum could not be observed. The above-mentioned integral relation, however, holds for what may be thought of as the linear part of the system. As a typical result, it has been found that the peripheral neural response, N_1 , to the step is equal to that of the pulse provided the pulse has the same height as the step, and a length of 20 μ sec. This holds over a fairly large range of amplitudes (20-40 db). Similar re-

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suits have been found for the other signals. Preliminary results will also be reported with respect to both microphonic and cortical responses to the above-mentioned stimuli.

MIT.12:211

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OFF-RESPONSES TO NOISE BURSTS AT THE AUDITORY CORTEX OF THE CAT (Abstract), by T. T. Sandel and N. Y.-S. Kiang. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Michigan U., Ann Arbor, Oct. 24-26, 1957.

Published in Jour. Acoust. Soc. Amer., v. 29: 1249, Nov. 1957.

In a previous report (November, 1956, 52nd meeting of the Acoustical Society) we concluded that cortical off-responses observed in cats under barbiturate anesthesia are in fact responses to acoustic transients that appear in the signal as it is turned off. We have since found in unanesthetized cats with high spinal sections off-responses that seem to occur in the absence of such acoustic transients. This conclusion is based on the following considerations: first, these off-responses are observed when bursts of noise are turned off and are abolished by injections of barbiturates; secondly, the latencies of these off-responses are 6-8 msec longer than the latencies of the previously reported off-responses to acoustic transients; and thirdly, these off-responses occur also under stimulus conditions which produce no off-responses in the anesthetized animal (burst durations shorter than 60 msec and fall times longer than 10 msec). These findings suggest that these off-responses in unanesthetized animals may involve neurons other than those which give rise to on-responses; the possibility that inhibitory neuronal links at levels below the auditory cortex are involved will be discussed.

MIT.12:212

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MEMBRANE CURRENTS IN CLAMPED VERTEBRATE NERVE, by J. del Castillo, J. Y. Lettvin and others. [1957] [2]p. incl. diagrs. (In cooperation with New York State U., Brooklyn) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]; and in part by U. S. Public Health [Service], Bell Telephone Labs., Inc., and National Science Foundation)
Unclassified

Published in Nature, v. 180: 1290-1291, Dec. 7, 1957.

The authors have devised voltage clamps for measuring membrane currents in both the node of Ranvier and cell bodies. An isolated node N_2 is laid across a window cut in a polyethylene tube through which flows Ringer solution. Two adjacent nodes, N_1 and N_3 , lie on glass slips separating the tube by air gaps. External shunts along the internodes are minimized by bathing the preparation in isotonic sucrose and playing an air jet on the internodes after gaps are made. The amplifiers used are direct-coupled through head stage emitting a current of less than 10^{-14} amp. Preliminary experiments indicate that the monophasic action potentials from isolated nodes are of 2 types: one shows a smooth fall-away from the peak; the other a marked downward inflexion somewhere in the falling phase.

MIT.12:213

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOTE ON THE MATRIX REPRESENTATION OF LINEAR TWO-PORT NETWORKS, by E. F. Bolinder. [1957] [3]p. incl. diagr. tables. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637)
Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-4: 337-339, Dec. 1957.

Matrix voltage-current representations and wave representations are given for linear two-port networks. Tables have been constructed which allow any voltage-current or wave matrix to be readily expressed in terms of any other matrix.

MIT.12:214

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME PROPERTIES OF THREE-TERMINAL DEVICES, by S. J. Mason. [1957] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637)
Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-4: 330-332, Dec. 1957.

A three-terminal device can be classified according to its deviation from three-way symmetry. Such classification offers a particularly compact and symmetrical expression of the passivity criterion and also relates the asymmetry of the device to the unilateral power gain obtainable with lossless bilateral coupling.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORY OF QUASI-STATIONARY ANALYSIS WITH APPLICATION TO FM INTERFERENCE AND VIDEO PROBLEMS (Abstract), by E. J. Baghdady. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

The convergence properties of the Carson and Fry and of the van der Poi-Stumpers expansions for the complex amplitude of the steady-state response of a filter to an FM excitation are discussed. The theory of quasi-stationary analysis and of FM-to-AM conversion with low distortion is presented. The use of Taylor's formula leads to error estimates and to a simple condition that specifies an upper bound on the error incurred in restricting the solution to the quasi-stationary term (the instantaneous-frequency method). A sluggishness ratio and an index of stiffness are defined for filters whose system functions have poles only in the left half-plane. Sluggishness ratios and indices are given for various filters of wide practical interest. The results indicate that filter bandwidths must be prescribed on the basis of the fastest rate at which the instantaneous frequency of the excitation is swept. Applications to sinusoidal modulation and to two-path interference that emphasize the limitations of specifying filter bandwidths on the sole basis of frequency deviation are offered. Applications to the reproduction of FM video waveforms are discussed.

MIT.12:216

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

COMMENTS ON "ELECTROSTATIC POTENTIAL IN CRYSTALS," by W. E. Nottingham. [1958] [2]p. incl. diagrs. table. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Amer. Jour. Phys., v. 26: 33-34, Jan. 1958.

The difference between "electrostatic potential" and "electric potential" is used to discuss the "work function" as it pertains to the forces acting on an electron either within the interior of a crystal or as the electron escapes through the surface boundary. The function is defined as the energy difference between the Fermi level in the interior of the conductor and an electron at rest in a field free space outside the conductor. The various principal plane surfaces of tungsten crystals are analyzed to determine the effects of atom spacing (i.e. subject to the presence of impurities and incomplete lattice structures) on the work functions. A close relation is

shown to exist between the variation in the tungsten work function with crystallographic direction and the probable perfection of the mirror-image surface that the electron "sees" as it leaves the metal.

MIT.12:217

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON THE STATICS AND DYNAMICS OF MAGNETIC DOMAIN BOUNDARIES, by J. V. Harrington. Jan. 13, 1958, 66p. incl. illus. diagrs. refs. (Technical rept. no. 338) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 110028

Unclassified

A semiclassical analysis of the variation of spin orientation in 180° and 90° domain walls is presented which takes into account both the rotational or latitude angle θ and the precessional or longitude angle ϕ of the macroscopic magnetization vector in ferromagnetic single crystals. The Euler equations for the crystal are derived for both ϕ and θ variations. Further static solutions of the Euler equation for 360° walls or two adjacent 180° walls of similar rotation driven together by an applied field are obtained. Some experimental verification of this is obtained from recent observations of Williams on double walls in thin films of nickel iron. By including the kinetic energy term characteristic of gyroscopic motion in the Lagrangian and assuming a Rayleigh dissipation function, the Euler equations for wall motion are obtained. A very general upper bound to the domain wall velocity is predicted, based only on known constants of the ferromagnetic lattice. A transient solution for the general equation of wall motion is obtained where the effects of wall mass are included. An interpretation of wall mass in terms of the macroscopic inertial moments of the spin system is given. (Contractor's abstract, modified)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SEPARATION AND IDENTIFICATION OF OVERLAPPING HYPERFINE STRUCTURE COMPONENTS: APPLICATION TO MERCURY RESONANCE RADIATION, by P. L. Sagalyn, A. C. Melissinos, and F. Bitter. [1958] [6]p. incl. illus. diagrs. tables. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Phys. Rev., v. 109: 375-380, Jan. 15, 1958.

A new technique has been developed for the separation of overlapping lines in the hfs pattern of atomic energy

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levels. By a combination of magnetic scanning and double resonance it was possible to resolve the 2537A line of mercury. By plotting the maxima of the microwave resonance versus scanning field, a separate curve was obtained for each F level of the odd isotopes. In the same way a curve was obtained showing the maxima of the resonance signals from all of the even isotopes. Information about the odd isotopes obtained from a 3000-mc/sec "double-resonance" experiment is also reported. Only minor disagreements with existing data were observed. (Contractor's abstract)

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 9, Jan. 29, 1958.

Interpretation of the operational properties of a solid-state maser, which we have operating in our laboratory, indicate that the process conventionally described as a spin-lattice relaxation indeed plays a dominant role in the operation of these devices. As has been pointed out, the spin-relaxation process must be extended to include phonon relaxation processes which in fact can dominate, in the sense that anomalous phonon temperatures can exist in the vicinity of the saturation frequency.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

LOW PRESSURE MICROWAVE PLASMA IN A MAGNETIC FIELD (Abstract), by D. O. Akhurst, S. J. Buchsbaum, and E. I. Gordon. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at the Tenth Annual Gaseous Electronics Conf., Cambridge, Mass., Oct. 2-4, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 87, Jan. 29, 1958.

A low pressure hydrogen plasma in a magnetic field is described. The plasma is contained in a narrow cylindrical quartz tube along the axis of a cylindrical microwave cavity that oscillates in the TE_{111} mode at a resonant wavelength of 10 cm. The configuration and strength of the magnetic field is such that electrons can gain energy from the microwave field through the cyclotron resonance effect. At high pressures both the breakdown and maintaining fields exhibit the well-known cyclotron resonance effect. However, at low pressures when the electron mean free path (in the absence of a magnetic field) is larger than the length of the quartz tube, it is easier to produce and maintain the plasma with a magnetic field a few percent off the value of magnetic field required for cyclotron resonance. Phenomena responsible for this "displaced" resonance are described.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

SOLID-STATE MASERS AND SPIN-LATTICE RELAXATION TIMES (Abstract), by C. F. Davis, M. W. P. Strandberg, and R. L. Kyhl. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A THEORY OF SIGNALS, by R. E. Wernikoff. Jan. 31, 1958, 98p. incl. diagrs. refs. (Technical rept. no. 331) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 158737 Unclassified

An experiment is presented in which an attempt is made to arrive at a mathematical description of physical signals that embodies, more realistically than the usual functional representation, our limitations in performing measurements. The object is to achieve a closer relation between the structure of the mathematical description and the finite-resolution properties of the detector that characterizes any real measurement process. An algebra of signals is obtained, appropriate to the model in which essentially frequency-limited signals interact with linear, time-invariant systems, and observations are made by means of a linear, finite-resolution oscilloscope. The properties of this algebra are studied, and a metric that indicates which operators give physically indistinguishable outputs is defined. The algebra is used to study problems in uniform and non-uniform sampling, the discrimination of two events from one in noisy, radar-like systems, and the conditions under which a signal is indistinguishable from its short-time average. A general procedure for linear, least-peak-error prediction is obtained. In the limit as the detector resolution becomes perfect, the present model is shown to tend smoothly to the usual functional model. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOTE ON IMPEDANCE TRANSFORMATIONS BY THE ISOMETRIC CIRCLE METHOD, by E. F. Bolinder. [1958] [2]p. incl. diagr. (Sponsored jointly by Signal

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Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637)
Unclassified

Published in I.R.E. Trans. of Professional Group on Microwave Theory and Techniques, v. MTT-6: 111-112, Jan. 1958.

A connection is given between the isometric circle method and the triangular method used in impedance transformations through bilateral two-port networks. A useful formula is presented for the reflection-coefficient transformations through lossless, bilateral two-port networks.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A PROPERTY OF DIELECTRIC CONSTANTS OF DIELECTRICS IN THERMAL EQUILIBRIUM, by M. Peter. [1958] [4]p. Incl. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Jour. Math. and Phys., v. 36: 347-350, Jan. 1958.

It has been shown that if a dielectric is passive, it will not be possible to apply a waveform in such a way as to gain power from the dielectric. This passivity imposes the necessary condition on the dielectric constant that it be a positive real function. Passive lumped circuits which are to be used as lumped models of equilibrium dielectric constant materials are discussed. Non-passive dielectrics lead to another circuit model which is illustrated.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FM DEMODULATOR TIME-CONSTANT REQUIREMENTS FOR INTERFERENCE REJECTION, by E. J. Baghdady. [1958] [9]p. Incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 432-440, Feb. 1958.

Under conditions of high-level interference fm receiver performance is often impaired because of improper low-frequency time constants in the limiter and discriminator circuits. The computation of the upper bounds on the permissible values of these time constants is illustrated.

Severe restrictions are indicated which often conflict with other fundamental requirements. The computational results of this paper demonstrate that these severe restrictions can be alleviated by means of simple schemes that will greatly enhance the capture performance of the fm receiver. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LATTICE DYNAMICS OF HEXAGONAL CLOSE-PACKED METALS. II. FREQUENCY SPECTRUM, by C. W. Garland and L. J. Slutsky. [1958] [4]p. Incl. diagrs. table, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Jour. Chem. Phys., v. 28: 331-334, Feb. 1958.

The frequency distribution spectrum of the normal modes of vibration for a hexagonal close-packed metal has been approximated by a root sampling technique applied to a central force model of the lattice. The calculation is made for magnesium with force constants obtained from the low temperature elastic constants. The calculated specific heat of magnesium from 0°K to 100°K is in quite good agreement with experiment. Other hexagonal metals are considered in terms of a reduced plot of θ (the equivalent Debye temperature) versus temperature. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SYNCHRONY OF NEURAL ACTIVITY IN ELECTRIC RESPONSES EVOKED BY TRANSIENT ACOUSTIC STIMULI, by M. H. Goldstein Jr. and N. Y.-S. Kiang. [1958] [8]p. Incl. illus. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 30: 107-114, Feb. 1958.

Electric responses evoked by transient acoustic stimuli were recorded by gross electrodes from the periphery and cortex of the cat. The responses to clicks and to the rapid onset of bursts of noise or tones are characterized by a sharp N_1 peak in the peripheral response and by a broader cortical response. When the rise time of the onset of bursts of noise (or tones) is lengthened, or when a burst of sudden onset is presented in a noise

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background, it is possible to obtain cortical responses under conditions for which the N_1 component of the peripheral response is undetectable. These results and associated findings are interpreted by considering the degree of synchronization of the discharge and the wave forms of the activity of units that contribute to responses recorded by gross electrodes. A simple statistical interpretation is presented. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ALGEBRAIC DECODING FOR A BINARY ERASURE CHANNEL, by M. A. Epstein. Mar. 14, 1958 [14]p. incl. diagrs. refs. (Technical rept. no. 340) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 208649 Unclassified

Also published in I.R.E. National Convention Record, Part 4: 56-69, 1958.

This paper presents an optimum decoding procedure for parity check codes that have been transmitted through a binary erasure channel. The erased digits are decoded by means of modulo 2 equations generated by the received message and the original parity check equations. Most previous decoding procedures required a number of computations that grew exponentially with code length. At best, the required number of computations grew as a polynomial of code length. The decoding procedure for convolution parity check codes presented here will decode with an average number of computations per digit that is bounded by a finite number, which is independent of code length, for any rate less than capacity. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OPERATION OF A SOLID STATE QUANTUM MECHANICAL AMPLIFIER, by M. W. P. Strandberg, C. F. Davis and others. [1958] [2]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Phys. Rev., v. 109: 1988-1989, Mar. 15, 1958.

The operation of an S-band solid-state quantum mechanical amplifier operated at 4.2°K with a computed noise temperature of less than 4.5°K is compared with

similar devices and is used as proof of the condition of discrete phonon saturation which has been previously postulated. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ANALYSIS OF NONLINEAR SYSTEMS BY MEANS OF GENERALIZED POLYNOMIALS (Abstract), by M. B. Brilliant. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at I.R.E. National Convention, New York, Mar. 24-27, 1958.

A form for the representation of nonlinear systems is developed. The dependence of the output on the past of the input is to be specified by a series of integral operators analogous to a power-series representation of a real function. The form is shown to be capable of arbitrarily close approximation to a fairly general class of systems. With the use of this form, methods are developed for computing the results of cascade and feedback combinations, and for approximating minimum-mean-square-error nonlinear filters. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CAPTURE OF THE WEAKER OF TWO COCHANNEL FM SIGNALS (Abstract), by E. J. Baghdady. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at I. R. E. National Convention, New York, Mar. 24-27, 1958.

Methods for achieving capture of the weaker of two co-channel FM signals are described. One approach extracts the modulation of the stronger signal and uses it to shift the resonant frequency of a dynamic trap that attenuates this signal. Another approach suppresses the stronger signal by an appropriate combination of the outputs of two signal paths that contain different numbers of narrow-band limiters. Alternative methods depend upon standard spectrum-resuffling techniques to synthesize a signal whose average frequency equals the frequency of the weaker signal. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

INVARIANCE PROPERTY OF CORRELATION OF RANDOM PROCESSES UNDER NONLINEAR TRANSFORMATION (Abstract), by A. H. Nuttall. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at I.R.E. National Convention, New York, Mar. 24-27, 1958.

When a certain class of random processes is transformed by a nonlinear, no-memory (instantaneous) device, the input-output cross-correlation function is identical, except for a known scale factor, with the input autocorrelation function, regardless of the kind of nonlinear device used. A necessary and sufficient condition for the invariance property to hold is formulated and proved. This condition is found to be related to an integral of the input second-order probability density function, and generalizes past results on the invariance property. Some general characteristics of the invariance-property class are derived; examples are given of the use of this property. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME APPLICATIONS OF DETECTION THEORY TO RADAR, by W. M. Siebert. [1958] [10]p. incl. illus. diags. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Presented at I.R.E. National Convention, New York, Mar. 24-27, 1958.

Published in I.R.E. National Convention Record, Part 4: 5-14, 1958.

This tutorial paper considers the problem of radar detector design in terms of statistical decision theory, with particular emphasis on the concept of sufficient statistics. Simple examples of the application of the theory are presented. Included as one example is the design of a detector to provide a constant false alarm rate in the face of a fluctuating noise level. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CHANGES ASSOCIATED WITH POST-TETANIC PO-

TENTIATION OF A MONOSYNAPTIC REFLEX, by P. D. Wall and A. R. Johnson. [1958] [11]p. incl. illus. diags. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Jour. Neurophysiol., v. 21: 148-158, Mar. 1958.

This paper examines post-tetanic potentiation of the monosynaptic reflex arc in the cat. It is shown by microelectrode stimulation that excitability is decreased in the primary afferent fibers and is unaffected in the motoneurons and neighboring passive fibers. The potentiation is, therefore, probably attributable to hyperpolarization of the presynaptic fibers. It is suggested that the delayed onset of the full potentiation is also attributable to presynaptic events, possibly anodal block. Evidence is presented that the post-tetanic change is greater in the terminal arborization than in other parts of the afferent axons. This difference may be an explanation of the "DRIV reversal" potential. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FOOTNOTES ON A HEAD STAGE, by J. Y. Lettvin, B. Howland, and R. C. Gesteland. [1958] [3]p. incl. diags. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637], Bell Telephone Labs., Inc., National Science Foundation, and Offner Electronics, Inc.) Unclassified

Published in I.R.E. Trans. of Professional Group on Medical Electronics, v. PGME-10: 26-28, Mar. 1958.

The principles, design details, and an actual circuit are given. An electrometer valve is used as a cathode follower and controlled by four feedback loops to give unity gain and linearity better than 1/1000 for signals < 10v. All stages are dc coupled. The circuit is sensitive to ripple variations in filament and anode supplies, so that a standard power unit requires additional regulation. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A SURVEY OF THE USE OF NON-EUCLIDEAN GEOMETRY IN ELECTRICAL ENGINEERING, by E. F. Bolinder. [1958] [18]p. incl. diags. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Jour. Franklin Inst., v. 265: 169-186, Mar. 1958.

A brief resumé is presented of some of the non-Euclidean geometry models and some of their applications in electrical engineering. The survey starts with a discussion of different two-dimensional and three-dimensional non-Euclidean geometry models, both of the hyperbolic and elliptic types. The interconnections of the two-dimensional models are studied geometrically and analytically by means of a simple impedance transformation example. The treatment is then formally extended to three-dimensional models. Finally, some applications of non-Euclidean geometry models in electrical engineering are discussed. An appendix gives a historical note on the evolution of non-Euclidean geometry. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SYNTHESIS OF SAMPLED-SIGNAL NETWORKS, by P. M. Lewis, II. [1958] [4]p. incl. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-5: 74-77, Mar. 1958.

This paper considers the problem of designing sampled-signal networks by using a finite number of passive, but not necessarily lumped, circuit elements. The resulting networks consist of resistors and open- and short-circuited transmission lines, all of which have the same delay.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SPIN-LATTICE RELAXATION, by M. W. P. Strandberg. [1958] [5]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Phys. Rev., v. 110: 63-69, Apr. 1, 1958.

The measurement of electron spin-lattice relaxation times for paramagnetic crystals at low temperatures is complicated by the fact that the spin specific heat can be much larger than the lattice specific heat. At low temperatures direct processes dominate in the spin-lattice relaxation mechanism and evidence exists that indicates that only a narrow portion of the phonon spectrum takes part in the relaxation processes. This situation is not

encompassed by usual treatments of the spin-lattice problem and a microscopic treatment is presented which allows for this selective excitation of the phonon spectrum. It is pointed out that phonon relaxation times can be the dominant quantity measured in the usual saturation spin-lattice relaxation measurements. The analysis indicates how pulse measurements may be used to evaluate the actual spin-lattice relaxation time independent of the phonon relaxation time. A discussion of some conditions under which the concept of temperature may be applied to quantum-mechanical systems interacting with electromagnetic fields; such as in solid-state amplifiers or absorbers, is given. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELECTRON BEAM WAVES IN MICROWAVE TUBES, by H. A. Haus. [1958] [44]p. incl. diagrs. refs. (Technical rept. no. 316) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 210913 Unclassified

Also published in Proc. Symposium on Electronic Waveguides, Polytechnic Inst. of Brooklyn, N. Y. (Apr. 8-10, 1958), N. Y., Interscience Publishers, 1958, p. 89-132.

A review is presented of wave propagation along electron beams and of the interaction of these waves with the fields of microwave structures, providing a basis for a unified theory of microwave amplifiers with distributed interaction. Beams with generalized momentum p which satisfies $\nabla \times p = 0$ are considered and a small signal power theorem is given. This theorem and the better-known theorem for longitudinal beams are interpreted. The waves along longitudinal beams, cylindrical Brillouin beams, and Brillouin strip-beams in crossed fields are reviewed and their small-signal power flows are studied. The interaction of waves in a longitudinal beam, traveling-wave tube is analyzed with the aid of Pierce's coupling-of-modes formalism. The small-signal power theorem is used in deciding whether or not exponential growth of a wave signifies gain. A variational principle is derived for longitudinal beams and beams with zero curl of the generalized momentum. For reasonable trial fields, the principle leads to Pierce's coupling-of-modes formalism, and can also be applied to study cases of stronger coupling than those analyzable by the coupling-of-modes theory. Equations of the magnetron amplifier are derived from the variational principle. (Contractor's abstract, modified)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PROPAGATION IN ION LOADED WAVEGUIDES, by L.

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D. Smullin and P. Chorney. [1958] [19]p. incl. diagrs. tables. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Proc. Symposium on Electronic Waveguides, Polytechnic Inst. of Brooklyn, N. Y. (Apr. 8-10, 1958), N. Y., Interscience Publishers, 1958, p. 229-247.

Cylindrical waveguides which are partially but uniformly filled with an ion plasma consisting of zero temperature movable ions and compensating infinite mass ions of opposite charge are considered. The propagation properties of these waveguides are studied in the presence of a uniform axial magnetic field. The Maxwell equations coupled with the force equations are straightforwardly solved in the case of small signals. A number of very-low-frequency waveguide pass bands are shown to exist in the region of the ion cyclotron frequency ω_c and ion plasma frequency ω_p if $\omega_c < \omega_p$ and $\omega_p < \omega_{\text{cutoff}}$ where ω_{cutoff} is the empty waveguide cutoff frequency. The solutions for low frequencies are found by means of a quasi-static approximation.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORY OF STRONGER-SIGNAL CAPTURE IN FM RECEPTION, by E. J. Baghdady. [1958] [11]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 728-738, Apr. 1958.

The characteristics of the FM disturbance that is caused by two-signal interference are pointed out and compared with the characteristics of message modulation. The comparison suggests a new role for the amplitude limiter in FM receivers. The limiter spreads out the spectrum which carries the FM disturbance over a frequency range that often exceeds many times the bandwidth requirements of the message modulation. This makes it possible to reject important parts of the interference spectrum by proper filtering in the output of the limiter without substantially affecting the spectrum of the message modulation. A repeated cycle of amplitude limiting and spectrum filtering is found to be an effective scheme for suppressing the disturbance ahead of the discriminator stage, and for improving the capture capabilities of an FM receiver. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELECTRON-STIMULATED ION OSCILLATIONS, by P. Chorney. May 25, 1956, 61p. incl. diagrs. refs. (Technical rept. no. 277) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 200516 Unclassified

Certain ion oscillations that are sometimes excited in microwave tubes were investigated on a theoretical basis. A study of some general properties of propagation in plasma-loaded waveguides was made; the plasma consisted of both stationary ions and an electron beam. The effect of an axial magnetic field was included in the analysis. Specifically, the propagation in waveguides that were loaded merely with a stationary ion plasma was studied. It was found that these waveguides are propagating structures at frequencies that are very low, as compared with the empty waveguide cutoff frequency. A short-circuited section of an ion-loaded waveguide, which was considered as a resonant cavity, was found to have resonant frequencies of the order of the ion plasma frequency and ion cyclotron frequency (a few megacycles per second for positive gas ions such as hydrogen). The energy transfer from a beam traversing an oscillating ion-loaded cavity to the fields of the cavity was established. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORY AND APPLICATION OF THE SEPARABLE CLASS OF RANDOM PROCESSES, by A. H. Nuttall. May 26, 1958, 57p. incl. illus. (Technical rept. no. 343) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 214552 Unclassified

The separable class of random processes is defined as that class of random processes for which the g -function, $g(x_2, \tau) = \int_{-\infty}^{\infty} (x_1 - \mu) p(x_1, x_2; \tau) dx_1$, separates into the product of 2 functions; a function only of x_2 , and a function only of τ . The second-order probability density function of the process is $p(x_1, x_2; \tau)$ and μ is its mean.

Various methods of determining whether a random process is separable are developed, and basic properties of the separable class are derived. A proof is presented that the separability of a random process that is passed through a nonlinear no-memory device is a necessary and sufficient condition for the input-output cross-covariance function to be proportional to the input autocovariance function, whatever nonlinear device is used. The uses of this invariance property are pointed out. If a

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nonlinear no-memory device is replaced by a linear memory-capable network, so as to minimize the mean-square difference between the two outputs for the same separable input process, analysis shows that the optimum linear network has no memory. Simple relations among correlation functions for these circuits are derived. Some results on Markov processes and best estimate procedure are derived, important examples of separable processes are given, and possible generalizations of separability are stated. (Contractor's abstract)

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

FINITE STATE LANGUAGES, by N. Chomsky and G. A. Miller. [1958] [22]p. incl. diagrs. tables. (Rept. no. AFCRC-TR-56-50) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]; National Science Foundation and Social Science Research Council) AD 146781 Unclassified

Also published in *Information and Control*, v. 1: 91-112, May 1958.

A finite state language is a finite or infinite set of strings (sentences) of symbols (words) generated by a finite set of rules (the grammar), where each rule specifies the state of the system in which it can be applied, the symbol which is generated, and the state of the system after the rule is applied. A number of equivalent descriptions of finite state languages are explored. A simple structural characterization theorem for finite state languages is established, based on the cyclical structure of the grammar. It is shown that the complement of any finite state language formed on a given vocabulary of symbols is also a finite state language, and that the union of any two finite state languages formed on a given vocabulary is a finite state language; i.e., the set of all finite state languages that can be formed on a given vocabulary is a Boolean algebra. Procedures for calculating the number of grammatical strings of any given length are also described. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LOW-NOISE 30-Mc AMPLIFIER, by J. K. D. Verma. [1958] [4]p. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) Unclassified

Published in *Rev. Scient. Instruments*, v. 29: 371-374, May 1958.

A low-noise 30-mc amplifier with Western Electric Type 416B triodes used in a cascode circuit is described. The theoretical noise figure of the amplifier, with the optimum value of source resistance, is 1.06 or 0.26 db. The amplifier is being used to study noise in semiconductors. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NUCLEAR RESONANCE SPECTRUM AND STRUCTURE OF SF_4 , by F. A. Cotton, J. W. George, and J. S. Waugh.

[1958] [2]p. incl. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in *Jour. Chem. Phys.*, v. 28: 994-995, May 1958.

The nuclear resonance spectrum of SF_4 has been found to have: (1) two equal intensity triplet lines which are 1920 cps apart; (2) an intensity ratio of 1:2:1 in the lines comprising each line; and (3) equal hyperfine separation (78 cps) in each triplet. These data suggest the nonplanar C_{2v} structure as most likely, in agreement with previous vibrational spectrum studies. This structure has five pairs of valence electrons in trigonal-bipyramidally directed sp^3d hybrid orbitals with the unshared pair in an equatorial orbital. The line spacing and temperature variation of line position yield an activation energy of 4 ± 1 kcal/mol.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON THE QUANTIZATION OF FINITE DIMENSIONAL MESSAGES, by M. P. Schützenberger. [1958] [6]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in *Information and Control*, v. 1: 153-158, May 1958.

Let L be the average value of a measure of quantization noise, and let H be the negentropy of the quantized signal. Some reciprocal relationship exists between these quantities, since, for example, increasing the number of possible quantized values reduces L but increases H . A lower bound to L is given as a function of H and shows that it may be realized up to a constant factor. Roughly speaking, this shows that every bit added to H multiplies

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Let α be a factor depending on the dimensionality of the message and the measure of quantization noise used.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

BASIC DATA OF ELECTRICAL DISCHARGES, by S. C. Brown and W. P. Allis. June 9, 1958, 188p. incl. diagrs. tables, refs. (Technical rept. no. 283; 4th ed.) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 203458 Unclassified

Basic data is reported on: (1) potential excitation and ionization energies of atoms and molecules in electron volts; (2) probabilities of the elastic and inelastic collision of electrons and ions, charge transfer, and photo-absorption; (3) surface phenomena including emissions and conversions; (4) motions, energies, and velocities of electrons and ions; (5) production and decay of ionization; (6) dc and ac breakdown and time lags; (7) electron energies; and (8) cathode phenomena such as cathode fall, back diffusion and sputtering.

MIT.12:248

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORY OF NOISY TWO-PORT NETWORKS, by E. F. Bolinder. June 14, 1958, 27p. incl. diagrs. refs. (Technical rept. no. 344) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) AD 208705 Unclassified

A new geometric-analytic theory of noisy two-port networks is presented. It is based, geometrically, on the isometric sphere method, a generalization of the isometric circle method to three dimensions, and, analytically, on a three-dimensional conformal transformation which was originally derived by Poincaré and Picard. The transformation is used in a study of transformations of noise ensemble average ratios through bilateral two-port networks. The study is facilitated by interpreting the transformations as non-Euclidean movements in the Poincaré and Cayley-Klein models of three-dimensional hyperbolic space. By a simple extension, noise ensemble average transformations are performed in four-dimensional spaces by means of four-vectors which are analogous to the Stokes vectors used in optics and antenna theory. The new theory has been used for studying several problems pertaining to noisy two-port networks: the Rothe and Dahlke method of splitting a noisy two-port network into noisy and noise-free ports, cascading of noisy two-port networks, noise

tuning and noise matching, the wave representation of noisy two-port networks, and the optimum noise factory. (Contractor's abstract)

MIT.12:249

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NUCLEAR DIPOLE-DIPOLE INTERACTIONS, by I. S. Waugh. [1958] [27]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637], and Petroleum Research Fund)

Unclassified

Published in *Ann. New York Acad. Sciences*, v. 70: 900-926, June 16, 1958.

The broad span of molecular problems that can be illuminated by nuclear magnetic resonance (NMR) experiments, particularly of the high resolution variety is presented. The entirely different range of effects that are observed in experiments on samples in the solid state is described. As a by-product, the sources of some limitations of high-resolution experiments will become evident. This paper is not a comprehensive review of "broad-line" spectroscopy; the literature of this field is voluminous and has already been thoroughly reviewed in a number of places. Rather, this material is intended as an introduction to and illustration of the better known effects of dipolar interactions for those who are not acquainted with them, but who are aware of the nature of the basic nuclear resonance phenomenon. Subject matter is limited to the direct nuclear dipole-dipole broadening of resonance lines and some remarks on spin-lattice interaction. Interesting and important subjects such as quadrupole coupling, electron paramagnetism, spin echoes, and electron-coupled interactions are omitted, although some of them have been customarily included in discussions of NMR spectroscopy in solids. (Contractor's abstract, modified)

MIT.12:250

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EXCITABILITY CHANGES IN AFFERENT FIBRE TERMINATIONS AND THEIR RELATION TO SLOW POTENTIALS, by P. D. Wall. [1958] [21]p. incl. illus. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in *Jour. Physiol.*, v. 142: 1-21, June 18, 1958.

A method is described by which the excitability of a group of axons may be tested along their course within the spinal cord. The experiments used a penetrating

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stimulating microelectrode and peripheral recording of the size of the antidromic volley originating from around the microelectrode. The results show that, after the passage of a single orthodromic volley, the excitability changes in the terminal arborization of afferent fibres differ, depending upon the nature of the fibre. The excitability changes in active proprioceptive fibres do not affect the excitability of their passive neighbors. The changes in both types of fibres do not depend on the presence of action potentials in post-synaptic cells. The excitability changes in the spinal course of the skin nerve axons are closely related to the dorsal root potentials.

MIT.12:251

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MECHANICAL TRANSLATION, by J. R. Applegate. [1958] [4]p. (Sponsored jointly by Signal Corps, Office of Naval Research, Air Force Office of Scientific Research, and National Science Foundation under [DA 36-039-sc-64637])
Unclassified

Published in Chem. Bul., v. 45: 23-26, June 1958.

The theoretical aspects of machine translation are discussed. Electronic computers now available have many properties which seem to make them well suited to this task, including input and output, memory units, and the ability to store, move, and compare information. The word-for-word method of machine translating is examined and its inadequacies enumerated. Another method, which appears to offer great promise of success, is a machine which would accurately translate sentences rather than words. The design, construction, and operation of such a machine is proposed and described.

MIT.12:252

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EFFECT OF INTENSITY DURATION AND SPECTRUM ON THE PERCEPTION OF TWO-ELEMENT AUDITORY SEQUENCES (Abstract), by T. T. Sandei and K. N. Stevens. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Washington, D. C., May 7-10, 1958.

Published in Jour. Acoust. Soc. Amer., v. 30: 674, July 1958.

Recently, interest has been shown in the perception of acoustic stimuli embedded in a sequence of sounds, particularly in relation to studies of speech perception. The particular question we have asked is: How is the perception of a given sound influenced by the physical parameters of a sound adjacent to it in temporal sequence? In the present experiments each stimulus comprises two components separated by a 10 msec gap; each component is a noise of specified band width, center frequency, intensity, and duration. Two of these stimuli are chosen as standards in a given experiment, and listeners are required to place other stimuli into one of the two categories typified by the standard stimuli. In a typical experiment, each of the standard stimuli consisted of two components that were equal in all respects except duration. After hearing these standards, subjects were required to categorize each of a series of ambiguous stimuli in which relative duration and intensity were manipulated. Results demonstrated a trading between intensity and duration, although the relations did not follow a simple pattern. In other experiments using different pairs of stimuli as standards, we have studied the influence of noise center frequency and band width as experimental variables.

MIT.12:253

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MICROWAVE-SPECTROSCOPY WAVE-GUIDE STARK CELL WITH HIGH PERFORMANCE CAPABILITIES, by M. W. P. Strandberg. [1958] [2]p. incl. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637)
Unclassified

Published in Rev. Scient. Instruments, v. 29: 656-657, July 1958.

The design of a Stark cell to be used in microwave spectroscopy has been described which has small dielectric loss and low noise level caused by the geometric modulation of the structure. The transmission characteristics of the cell are flat and without resonances. Construction details are provided.

MIT.12:254

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NUCLEAR RESONANCE STUDY OF STRUCTURE AND MOLECULAR MOTIONS IN SOME COBALT COMPLEX SALTS, by G. R. Murray, Jr. and J. S. Waugh. [1958] [7]p. incl. diagrs. tables, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637)
Unclassified

MIT.12:255- MIT.12:258

Published in Jour. Chem. Phys., v. 29: 207-213, July 1958.

Line widths and second moments of the proton and F^{19} resonances in $Co(NH_3)_6X_3$ ($X = Cl, Br, I, NO_3, BF_4, PF_6$) were measured from 90° to 400°K. In the first four, unusual and very broad (~ 200°K) line-width transitions were observed. These are interpreted by postulating crystal structures containing nonequivalent sites for $Co(NH_3)_6^{+++}$ ions in relative abundances 3:1, 1:1, 1:1, and 2:1, respectively. This interpretation was verified in one case by x-ray diffraction. $Co(NH_3)_6(BF_4)_3$ showed a normal line-width transition which is interpreted both by the usual correlation theory and by a very detailed analysis to give $\Delta E \approx 12$ kcal/mol and $\tau_0 \approx 10^{-14}$ sec. At 90°K rapid reorientation of $-NH_3$ groups and of BF_4^- and PF_6^- ions occurs in all of these salts. At 330°K and above, rapid tumbling of $Co(NH_3)_6^{+++}$ ions occurs. (Contractor's abstract)

MIT.12:255

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON VOWEL INTONATION CONTOURS (Abstract), by P. Lieberman. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Washington, D. C., May 7-10, 1958.

Published in Jour. Acoust. Soc. Amer., v. 30: 681-682, July 1958.

Synthetic three formant vowels were recorded with thirty-two different intonation contours, by varying the fundamental frequency as a function of time. The perceptual effects of these variations were investigated in a test in which listeners were required to discriminate between different intonation patterns. The reliability of the discriminations was correlated with the direction in which the intonation contour shifted, the rate of the shift and its magnitude. The relevance of the results to the problem of English sentence intonation is briefly discussed.

MIT.12:256

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

POWER-FLOW RELATIONS IN LOSSLESS NONLINEAR MEDIA, by H. A. Haus. [1958] [8]p. incl. diagrs.

[Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637]
Unclassified

Published in I.R.E. Trans. of Professional Group on Microwave Theory and Techniques, v. MTT-6: 317-324, July 1958.

The Manley-Rowe relations, originally derived for nonlinear lumped circuit elements, are generalized to include the power flow in the fields produced in the presence of lossless, nonlinear media. The generalization is carried out first for nonlinear anisotropic media with single-valued relations between the instantaneous \vec{E} and \vec{P} , and \vec{H} and \vec{M} . The proof is extended to include gyromagnetic media under small-signal excitation at the signal frequency (but large excitation at the pump frequency). The relations are applied to show under what conditions power gain can be achieved with a three-frequency and a four-frequency excitation of a ferrite. The form of the coupling coefficients in the electromagnetic operation of a ferrite amplifier is shown to be a consequence of the generalized Manley-Rowe relations. (Contractor's abstract)

MIT.12:257

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MICROMODULATOR--A DEVICE FOR MEASURING THE INTENSITIES OF MICROWAVE ABSORPTION LINES, by R. L. Mattuck and M. W. P. Strandberg. [1958] [5]p. incl. illus. diagrs. table. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])
Unclassified

Published in Rev. Scient. Instruments, v. 29: 717-721, Aug. 1958.

A simple device for rapid measurement of the intensities of microwave absorption lines has been constructed. It requires only a small electromagnet and power supply and utilizes a free electron resonance to provide a standard comparison line at any frequency from 0 to 40 kmc. Preliminary tests carried out on ammonia at K band indicate reproducible results with errors of less than + 30% in most cases. Suggestions are made for improving the accuracy of the measurements. (Contractor's abstract)

MIT.12:258

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OPTIMUM NOISE PERFORMANCE OF LINEAR AMPLIFIERS, by H. A. Haus and R. B. Adler. [1958]

MIT.12:259 - MIT.12:261

[17]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637)

Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 1517-1533, Aug. 1958.

A single quantitative measure of amplifier spot noise performance is established. It removes difficulties heretofore associated with the effect of feedback upon spot noise performance. This measure, $(M_e)_{opt}$, is a function of the amplifier noise and circuit parameters alone. It determines the lowest spot noise figure achievable at high gain with a given amplifier, which is used either alone or in a passive interconnection with other amplifiers of the same $(M_e)_{opt}$. Moreover, passive interconnection of amplifiers with different $(M_e)_{opt}$ cannot lead to a spot noise figure at high gain better than that obtainable by using only amplifiers of the smallest $(M_e)_{opt}$. $(M_e)_{opt}$ is, therefore, a valid measure of the absolute quality of amplifier noise performance. In many important cases the best noise performance attainable with a particular type of amplifier is actually achieved by a simple cascade in which the input of each stage is properly mismatched. The mismatch conditions for each stage do not in general coincide with those normally used to "minimize" its noise figure. In the case of a two-terminal-pair negative resistance amplifier, a limiting form of which is the maser, optimization may always be obtained using an ideal circulator. (Contractor's abstract)

MIT.12:259

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DIRECT MEASUREMENT OF ELECTRON SPIN-LATTICE RELAXATION TIMES, by C. F. Davis, M. W. P. Strandberg and P. L. Kyhl. [1958] [5]p. incl. illus. diagrs. table, refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])

Unclassified

Published in Phys. Rev., v. 111: 1268-1272, Sept. 1, 1958.

A discussion of the experimental problems encountered in making spin-lattice relaxation measurements in electron paramagnetic systems at low temperature is presented. Gadolinium and chrome ion spin-lattice relaxation times, measured by a pulse saturation technique in the time domain, are given. The relation of these spin-lattice relaxation times with relaxation times measured in the frequency domain by observing a saturation parameter is discussed. (Contractor's abstract)

MIT.12:260

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELASTIC CONSTANTS OF ZINC FROM 4.2°K to 77.6°K, by C. W. Garland and R. Dalven. [1958] [3]p. incl. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637])

Unclassified

Published in Phys. Rev., v. 111: 1232-1234, Sept. 1, 1958.

The adiabatic elastic constants of zinc single crystals have been measured by an ultrasonic pulse technique. The values extrapolated to 0°K are: $c_{11} = 1.770$, $c_{33} = 0.385$, $c_{44} = 0.459$, $c_{12} = 0.348$, $c_{13} = 0.528$ in units of 10^{12} dynes/cm². A Debye characteristic temperature, θ , of $327 \pm 5^\circ\text{K}$ has been calculated at 0°K by averaging the inverse cube of the longitudinal and transverse elastic wave velocities over all directions of propagation. (Contractor's abstract)

MIT.12:261

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CANONICAL FORM OF LINEAR NOISY NETWORKS, by H. A. Haus and R. B. Adler. [1958] [7]p. incl. diagrs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637)

Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-5: 161-167, Sept. 1958.

Lossless network transformations are performed on noisy networks, keeping the number of terminal pairs fixed. These transformations are used to find the fundamental form of the network which explicitly uncovers the noise characteristics of the network which are independent of the form of the network. An n-terminal-pair network has n eigenvalues that are independent of the form of the transformed network. A transformation to a single pair terminal network is given which shows that the n values of the exchangeable power of this network are identical, except possibly for sign with the eigenvalues of the characteristic noise matrix. In a network in which no special circuit parameter has been chosen, the invariants are shown to possess different significance. In the general circuit parameter representation it is the noise measure whose extrema are determined by the eigenvalues of the associated noise matrix.

MIT.12:262 - MIT.12:265

MIT.12:262

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NETWORK REALIZATION OF OPTIMUM NOISE PERFORMANCE, by R. B. Adler and H. A. Haus. [1958] [8]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-5: 156-161, Sept. 1958.

The following theorem is derived from the results of this paper: (1) any unilateral amplifier with $U > 1$ may be optimized with input mismatch alone. (2) A nonunilateral amplifier with $U > 1$, which is also stable for all passive source and load impedances, may be optimized with input mismatch alone. (3) Any amplifier with $U > 1$ may be optimized by first making it unilateral, using lossless reciprocal networks, and subsequently employing input mismatch. (4) Amplifiers of the class $U < 0$ can be optimized by first transforming them into the class $U > 1$ by nonreciprocal imbedding. The optimization methods (1) to (3) can then be applied to this class. (5) Negative resistance amplifiers ($0 < U < 1$) can be optimized by first transforming them into the canonic form. The terminal pair of the canonic form which possesses the smaller exchangeable power is connected into a lossless circulator with a positive (1 Ω) balancing resistor. The resulting unilateral two-terminal-pair network achieves the optimum noise measure.

MIT.12:263

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORY OF LOW-DISTORTION REPRODUCTION OF FM SIGNALS IN LINEAR SYSTEMS, by E. J. Baghdady. [1958] [13]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-5: 202-214, Sept. 1958.

The purpose of this paper is to cover certain fundamental aspects of the analysis of linear-system response to variable-frequency excitations. The main objectives are: (1) the presentation of a unified treatment of the fundamental expansions of Carson and Fry and of Van der Pol and Stumpers that simplifies their derivation and brings out their (not so well known) convergence properties; (2) the derivation of bounds on errors incurred in using only a finite number of the earlier terms in these expansions; (3) the derivation of the general fundamental condition for the validity of a quasi-static argument in analyzing the response of a linear system to an FM signal (the instantaneous-frequency approach);

and (4) an analysis of the conditions for low-distortion processing of FM signals that leads to the definition of a more complete, straightforward approach to the design of linear FM transmission and FM-to-AM conversion filters.

MIT.12:264

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE KINETIC POWER THEOREM FOR PARAMETRIC, LONGITUDINAL, ELECTRON-BEAM AMPLIFIERS, by H. A. Haus. [1958] [8]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637]) Unclassified

Published in I.R.E. Trans. of Professional Group on Electron Devices, v. ED-5: 225-232, Oct. 1958.

A power theorem is developed for parametric, longitudinal, electron-beam amplifiers which may be considered as a generalization of Chu's well-known kinetic power theorem. The new power theorem is used to explore the limitations on noise performance of parametric electron-beam amplifiers. It is shown that the electron-beam noise does not impose a basic limit on the noise performance of a parametric electron-beam amplifier in the way a basic limit is imposed upon the noise performance of conventional longitudinal electron-beam amplifiers. The new power theorem can be employed for understanding the operation of parametric beam amplifiers in the same way as Chu's kinetic power theorem has been used for interpreting the operation of longitudinal beam amplifiers. (Contractor's abstract)

MIT.12:265

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NEW METHOD OF MEASURING THE NOISE PARAMETERS OF THE ELECTRON BEAM, ESPECIALLY THE CORRELATION BETWEEN ITS VELOCITY AND CURRENT FLUCTUATIONS, by S. Saito. Aug. 22, 1957, 50p. incl. illus. diags. tables, refs. (Technical rept. no. 333) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637) Unclassified

Also published in I.R.E. Trans. of Professional Group on Electron Devices, v. ED-5: 264-275, Oct. 1958.

The noise figure of a microwave beam amplifier has a lower limit that depends entirely upon the noise process in the electron gun at and near the potential minimum. This report is chiefly concerned with the theory and experimental results of a new method of measuring the noise parameters of the electron beam, especially the

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correlation between its velocity and current fluctuations, by using a selective beam coupler that has properties similar to the conventional microwave directional coupler. The value of the correlation coefficient of the velocity and current fluctuations was found to be from 0.2 to 0.35 in the space-charge-limited region and zero, or slightly negative, in the temperature-limited region. The probable error of this measuring method is discussed by taking account of the residual selectivity of the selective beam coupler, the effect of the pickup cavities upon the beam, the thermal noise from these cavities, and the higher-order modes. (Contractor's abstract)

MIT.12:266

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

DESIGN OF EXAMINATIONS AND INTERPRETATION OF GRADES, by M. W. P. Strandberg. [1958] [4]p. [Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-64637] Unclassified

Published in Amer. Jour. Phys., v. 26: 555-558, Nov. 1958.

There are two inadequacies of usual teaching methods about which something can be done. The design and evaluation of examinations, as popularly applied, are nonquantitative; and the average student is inadequately prepared for understanding the learning process. Three criteria are presented which may be of use in resolving these difficulties. These criteria are the concept of logical steps, the concept of avenues of approach, and the concept of the nature of examinations. (Contractor's abstract)

MIT.12:267

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MICROWAVE METHOD FOR MEASURING THE PROBABILITY OF ELASTIC COLLISION OF ELECTRONS IN A GAS, by J. L. Hirschfield and S. C. Brown. [1958] [4]p. Incl. illus. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, Air Force Office of Scientific Research, and Atomic Energy Commission under [DA 36-039-sc-64637]) Unclassified

Published in Jour. Appl. Phys., v. 29: 1749-1752, Dec. 1958.

A plasma in a dc magnetic field has a transverse conductivity component whose reactive part depends, as to both magnitude and sign, on the strength of the magnetic field. By measuring the value of magnetic field that is necessary for bringing this reactive part to zero--and

hence removing any resonant-frequency shifts to a TE_{011} mode of a cylindrical cavity containing the plasma--determination of the probability of elastic collision of electrons in helium is obtained as a check on the method. The value of $P_m = 20 \pm 1 \text{ cm}^{-1} \text{ mm Hg}^{-1}$ for the electrons at room temperature thus obtained agrees substantially with the value obtained by previous workers. Sources of error in the measurement are discussed. (Contractor's abstract)

MIT.12:268

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PROBLEMS AND POSSIBILITIES WITH MICROWAVE QUANTUM MECHANICAL AMPLIFIERS (Abstract), by M. W. P. Strandberg. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-64637; continued by DA 36-039-sc-78108]) Unclassified

The most recent additions to the solid state field are the microwave amplifiers. These remarkable devices, variously called the maser (microwave amplification by stimulated emission of radiation), or the versitron, when operated at low temperatures show promise of improving receiver sensitivity by a factor of a thousand. This improvement of 30 db will greatly increase the range of radar sets and may well make world-wide television networks a possibility through the use of scatter propagation. (Contractor's abstract)

MIT.30:001

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HOW CAN THE MULTIPLICITY OF THE GROUND STATE WAVE FUNCTION OF LIQUID HELIUM BE INFERRED FROM THERMOSTATICS (Abstract), by L. Tisza. 1958 [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-78108; continuation of DA 36-039-sc-64637]) Unclassified

Presented at Kamerlingh Onnes Conf. on Low Temperature Physics, Leyden (Netherlands), June 23-28, 1958.

Published in Physica, Suppl., v. 24: S137-S138, Sept. 1958.

It was recently pointed out that a sharpened version of the phase rule in conjunction with the observation of λ -line singularity in liquid helium leads to the inference that the ground state wave function is doubly degenerate. This result is surprising, partly, because it conflicts with the tacit or explicit assumption of the existing quantum mechanical theories, partly because the rigorous

MIT.30:002 - MIT.30:005

arguments of traditional thermodynamics do not lead to such quantum mechanical statements. The conclusion in question was reached from a new axiomatization thermodynamics. A characteristic aspect of this approach is that the choice of axioms is flexible and allows one to deal rigorously with questions of increasing incisiveness. In addition to the thermostatics of phase equilibrium, the theory is now developed on statistical lines.

MIT.30:002

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE STUDY OF PLASMAS THROUGH THEIR INTERACTION WITH HIGH FREQUENCY ELECTROMAGNETIC WAVES (Abstract), by G. Bekefi. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274) (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-78108]; and in part by Atomic Energy Commission) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The interaction of electromagnetic radiation with a gaseous plasma is used in the study of some physical properties of plasmas. In general, the interaction is characterized by two quantities: by the attenuation and by the phase shift which an electromagnetic wave suffers in its passage through the plasma. Experiments yield such basic parameters as the electron density, electron-atom and ion-atom collision cross sections, electron temperatures, electron energy losses on impact, and depletion rates of electrons by diffusion and recombination. In particular measurement of the following parameters is discussed both in isotropic plasmas and in plasmas acted upon by dc magnetic fields: (1) high electron densities, (2) electron-molecule collision cross sections and electron energy loss on impact, and (3) microwave noise radiation emitted.

MIT.30:003

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

COLLISION CROSS SECTION AND ENERGY LOSS OF SLOW ELECTRONS IN HYDROGEN, by G. Bekefi and S. C. Brown. [1958] [6]p. incl. diagrs. refs. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-78108] and in part by Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 112: 159-164, Oct. 1, 1958.

Values for the collision cross section for momentum transfer and the fractional energy lost by an electron

on collision with a hydrogen molecule were obtained from measurements of the microwave conductivity of a gaseous plasma. The experiments were made in the afterglow of a pulsed discharge in a cavity resonating at a wavelength of 10 cm. The mean electron energy was varied from 0.04 ev (room temperature) to 0.08 ev by heating the gas, and from 0.04 ev to 1.6 ev by microwave agitation of the electrons alone. The collision probability in molecular hydrogen at electron energies in the neighborhood of 0.04 ev is found to be $28.5 (v/v_0)^{0.55}$

(cm-mm Hg) $^{-1} \pm 3\%$, where v is the electron velocity, and v_0 the most probable velocity at 300°K. Measurements in deuterium gas gave the same result. The collision probability in hydrogen increases to a peak value

of 64 (cm-mm Hg) $^{-1} \pm 7\%$ at an electron energy of approximately 1.4 ev. The energy loss of electrons near room temperature was found by comparing the conductivity measurements obtained by thermal agitation with those obtained by microwave agitation of the electrons. The fraction of the excess electron energy lost on collision with the hydrogen molecule is $(3.5 \pm 0.5) \times 10^{-3}$.

In the higher energy range, the loss and the collision probability were computed from a comparison between microwave conductivity measurements and electron drift velocity and diffusion experiments.

MIT.30:004

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EXTRACRANIAL RESPONSES TO ACOUSTIC CLICKS IN MAN, by C. D. Geisler, L. S. Frishkopf, and W. A. Rosenblith. [1958] [2]p. incl. diagr. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under [DA 36-039-sc-78108]) Unclassified

Published in Science, v. 128: 1210-1211, Nov. 14, 1958.

Electronic averaging of potentials recorded from the human scalp reveals the presence of small average responses following the presentation of click stimuli. These responses are first detectable near the subject's psychophysical threshold and vary in amplitude with click intensity. It is suggested that the short-latency components of these responses are cortical in origin. (Contractor's abstract)

MIT.30:005

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AUTOCORRELATION AND CROSSCORRELATION ANALYSIS IN ELECTROENCEPHALOGRAPHY (Abstract), by J. S. Barlow. [1958] [1]p. (In cooperation with Massachusetts General Hospital, Boston)

MIT.30:006 - MIT.30:007

(Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-78108) Unclassified

Presented at Eleventh annual Conf. on Electrical Techniques in Med. and Biol., Minneapolis, Minn., Nov. 19-21, 1958.

Also published in I.R.E. Trans. of Professional Group on Medical Electronics, v. ME-6: 179-183, Mar. 1959.

Autocorrelation and crosscorrelation analysis, which have been used extensively in statistical communication theory in the last several years, may be applied to the study of the EEG, with certain limitations. Autocorrelation functions for normal subjects may be classified into several categories, according to the dominant frequency or frequencies (if any) present, and other parameters. Crosscorrelation of EEG recordings from different locations on the head permit a comparison of the electrical activity at the two locations. Correlation functions and power density spectra contain equivalent information, since the one may be obtained from the other by Fourier transformation, but, because of the squaring and multiplication which appear in the computation process, the data so obtained are not exact equivalents of the frequency spectra derived from tuned resonators. A special case of crosscorrelation analysis, viz., crosscorrelation of a repetitive signal with a synchronously occurring brief pulse, may be applied to the detection of electrical responses evoked by sensory stimulation. This process is equivalent to averaging a large number of individual responses. The types of analyses described above may be used in a complementary fashion to study the rhythmic activity of the brain under a variety of conditions. Illustrative examples, obtained from semi-automatic computers especially designed for the purpose, are shown. (Contractor's abstract)

MIT.30:006

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STATISTICAL CHARACTERISTICS OF EVOKED CORTICAL ACTIVITY (Abstract), by T. [T.] Sandel and T. Weiss. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-78108) Unclassified

Presented at Eleventh annual Conf. on Electrical Techniques in Med. and Biol., Minneapolis, Minn., Nov. 19-21, 1958.

The experimenter analyzing cortical activity evoked by sensory stimuli is faced with at least two major sources of difficulty. First, he is unaware of the number and nature of the processes responsible for the potentials he observes and second, the system under study is so complex that even if the processes were known, it is

unlikely that he could predict population responses with any precision on the basis of single unit responses. In such a situation a probabilistic approach to the problem is desirable. An attempt to utilize such a probabilistic approach in the analysis of cortical activity evoked by various auditory stimuli has been made. Since such an approach is predicated on large samples of evoked responses, two digital computers, one special purpose (ARC-1) and another general purpose (TX-0), have been used for analysis. The analysis consists essentially of: (a) averaging large numbers of responses evoked by an invariant stimulus, (b) obtaining amplitude distributions at various times following stimulus delivery, and (c) computing the medians, quartiles, and quartile intervals of these amplitude distributions. Results are presented and discussed. (Contractor's abstract)

MIT.30:007

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

APPARATUS FOR THE GENERATION OF PSYCHO-ACOUSTIC STIMULI VARYING IN COMPLEXITY FROM NOISE BURSTS TO SYLLABLES (Abstract), by G. Rosen and K. N. Stevens. [1958] [1]p. (Sponsored jointly by Signal Corps, Office of Naval Research, and Air Force Office of Scientific Research under DA 36-039-sc-78108) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago U., Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 114, Jan. 1959.

Apparatus designed to control a speech synthesizer is described. The equipment is also useful for the generation of a large class of complex acoustic stimuli. It may be likened to a computer with both digital and analog elements. In the digital portion a system of counters and gates generates a 100-point time base. These points can be "picked-off" as pulses to trigger flip-flops, relays and function generators in a large variety of possible temporal programs. In the analog portion, the function generators provide piecewise-linear amplitude envelopes for buzz and noise sources and are also used in the synthesizer for programming changes in articulation or in formant frequencies as well as changes in fundamental frequency. The buzz and noise generators use novel diode amplitude control circuits to circumvent the shortcomings of balanced modulators. The logical design of the timing circuits is such that, in many cases, each experimental variable may be under the control of a single switch, so that tests may be recorded rapidly and accurately. Examples of the use of the apparatus in studies of the synthesis of speech and in the generation of stimuli for more general psychophysical experiments are given.

MIT.30:008 - MIT.30:011

MIT.30:008

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

THE DETECTABILITY OF SMALL IRREGULARITIES
IN A BROAD-BAND NOISE SPECTRUM (Abstract), by
C. I. Malme and K. N. Stevens. [1958] [1]p. (Sponsored
jointly by Signal Corps, Office of Naval Research, and
Air Force Office of Scientific Research under DA 36-
039-sc-78108) Unclassified

Presented at meeting of the Acoust. Soc. Amer.,
Chicago U., Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 120, Jan.
1959.

The detectability of small changes in the energy content
of a narrow frequency band in an otherwise white noise
spectrum is measured using standard psychoacoustical
testing techniques. The test stimuli are obtained by
passing a white noise spectrum (100 cps - 10 kc) through
a filter having a simple resonance and antiresonance.
The positions of the corresponding pole and zero in the
transfer function are varied to produce either a peak or
notch (alone or simultaneously) in the output spectrum.
The bandwidth and center-frequency of the resulting
irregularities are specified in terms of the positions of
the poles and zeros in the s-plane plot. The stimuli
are presented to the subjects by an electrostatic loud-
speaker having a relatively flat frequency response
throughout the range of interest. The experimental re-
sults show the magnitude of a generally detectable spec-
trum irregularity as related to the pole and zero po-
sition in the transfer function of the filter. For example,
a spectrum notch centered at 1000 cps requires a band-
width of about 75 cps to be detectable by an average
listener when compared with the flat noise spectrum.

This corresponds to a zero at $s = -235 + j6280 \text{ sec}^{-1}$
in the filter transfer function. The application of the
experimental results to determine the amount of fre-
quency response irregularity allowable in high-fidelity
loudspeakers is discussed. Other possible applications
in the field of speech research and audio engineering
are enumerated.

MIT.30:009

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

EFFECT OF DURATION UPON VOWEL IDENTIFICA-
TION (Abstract), by K. N. Stevens. [1958] [1]p. (Spon-
sored jointly by Signal Corps, Office of Naval Research,
Air Force Office of Scientific Research under DA 36-
039-sc-78108, and National Science Foundation) Unclassified

Presented at meeting of the Acoust. Soc. Amer.,
Chicago U., Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 109, Jan.
1959.

The purpose of this experiment is to determine the
extent to which both duration and formant frequencies
play a role in the identification of American English
vowels. A resonance analog synthesizer was used to
generate a number of cvc syllables in which the initial
and final consonants were always [d] and [s] respectively.
The durations of the vowels were given values from 20
to 500 msec. Two series of stimuli were recorded and
were presented to listeners in random order. In the
first test the frequencies of the first three formants of
the vowel varied in several steps to encompass values
appropriate for the front vowel series [i I A ae], and
the listeners were asked to identify the vowel as one of
these; in the second test the back vowels [u U Ao] were
studied. The results indicated the [i I] and [u U] dis-
tinctions [e ae] and [Ao] are strongly influenced by dura-
tion. In a similar experiment in which the stimuli were
mixed with noise, the influence of vowel duration was
even more marked. The results are discussed in the
light of existing data on vowel perception.

MIT.30:010

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

IDENTIFICATION OF SPEECH SOUNDS BY MEANS OF
A DIGITAL COMPUTER (Abstract), by G. W. Hughes.
[1958] [1]p. (Sponsored jointly by Signal Corps, Office
of Naval Research, Air Force Office of Scientific Re-
search under DA 36-039-sc-78108, and National Science
Foundation) Unclassified

Presented at meeting of the Acoust. Soc. Amer.,
Chicago U., Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 113, Jan.
1959.

A digital computer (MIT Whirlwind 1) has been pro-
grammed to analyze speech. Present programs are
capable of classifying different portions of the speech
signal as vowel, fricative, nasal, or silence, and of
tracking vowel formant with some accuracy. On the basis
of these data procedures have been devised for identify-
ing a number of words.

MIT.30:011

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

DIPOLE AND QUADRUPOLE MOMENTS OF ISOMERIC
RADIOACTIVE Hg^{197} ; ISOMERIC ISOTOPE SHIFT (Ab-
stract), by A. C. Melissinos and S. P. Davis. [1959]
[1]p. (Sponsored jointly by Signal Corps, Office of Naval

MIT. 80:012-014; MAS. 01:002

Research, and Air Force Office of Scientific Research
under DA 36-039-sc-78108) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago,
Ill., Nov. 28-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
371, Nov. 28, 1958.

The hyperfine structure (hfs) of five optical lines of the 65-hour radioactive Hg^{197} and the 25 hour isomeric Hg^{197} atom has been measured with a 10 in. grating in the 15th order. Radioactive mercury was produced by cyclotron bombardment; electrodeless discharge tubes with 5×10^{12} atoms gave satisfactory results. The analysis of the hfs confirmed the nuclear dipole moment and isotope shift of Hg^{197} in the $I = 1/2$ ground state (known from double resonance) (1), and gave the following values for the isomeric nucleus: Spin $I = 13/2$; dipole moment $\mu_{197} = -1.037 \pm .020$ nuclear magnetons; quadrupole moment $Q_{197} = (+1.50 \pm .50 \text{ } ^{124}\text{cm}^2 - .75 \text{ } ^{124}\text{cm}^2)$ and isotope shift in the 2537 Å line $(+69 \pm 6) \times 10^{-3} \text{ cm}^{-1}$ (mk). Thus an (isomeric) shift of atomic energy levels due to the excitation of the nucleus is observed, and found to be -22 ± 8 mk.

MIT.30:012

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

EFFECT OF A MAGNETIC FIELD IN THERMIONIC
EMISSION FROM MOLYBDENUM, by J. Greenburg.
[1958] [3]p. (Sponsored jointly by Signal Corps, Office
of Naval Research, and Air Force Office of Scientific
Research under DA 36-039-sc-78108) Unclassified

Published in Phys. Rev., v. 112: 1898-1900, Dec. 15,
1958.

An experiment that was performed to explore the possible effect of an external magnetic field on thermionic emission from a clean metal surface demonstrated that an applied field of 6000 gauss or less has no effect on the saturation current density. The purpose of this study was to resolve, if possible, the disagreement between the work of Shelton and that of Nottingham and Hutson on the energy distribution of thermionically emitted electrons. (Contractor's abstract)

MIT.30:013

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

CARBON-13 NUCLEAR RESONANCE SPECTRUM AND
LOW FREQUENCY INFRARED SPECTRUM OF IRON

PENTACARBONYL, by F. A. Cotton, A. Danti and
others. [1958] [2]p. (Sponsored jointly by Signal Corps,
Office of Naval Research, and Air Force Office of
Scientific Research under DA 36-039-sc-78108)
Unclassified

Published in Jour. Chem. Phys., v. 29: 1427-1428, Dec.
1958.

The structure of $\text{Fe}(\text{CO})_5$ is not yet known with certainty. While most workers apparently favor the trigonal bipyramid structure originally proposed on the basis of electron diffraction studies, O'Dwyer has recently claimed that the vibrational spectrum can best be interpreted assuming a square-base pyramid structure. In an attempt to resolve the uncertainty, studies have been undertaken of NMR and vibrational spectra of $\text{Fe}(\text{CO})_5$. The data obtained appear to be more consistent with the D_{3h} than the C_{4v} model.

MIT.30:014

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

PERIPHERAL AND CORTICAL RESPONSES TO
MECHANICAL STIMULATION OF THE CAT'S
VIBRISSAE (Abstract), by W. D. Keidel, U. O. Keidel,
and N. Y.-S. Kiang. [1958] [1]p. (Sponsored jointly by
Signal Corps, Office of Naval Research, and Air Force
Office of Scientific Research under DA 36-039-sc-
78108) Unclassified

The space-time pattern of electric responses to pulling of cats' vibrissae was studied by recording with gross electrodes placed on maxillary nerve and somatic cortex. Single and repetitive mechanical stimulation at many intensities was used. Particular attention was paid to the time course of adaptation of responses to trains of stimuli. The results show that even with single stimulus patterns, the response patterns are complex. There is clear indication that adaptation can be demonstrated in cortical responses which does not correspond to any adaptation at the periphery. Some differences were observed between responses from unanesthetized cats with high spinal sections and from cats that were anesthetized with Dial. (Contractor's abstract)

MAS.01:002

Massachusetts U. Dept. of Chemistry, Amherst.

O-ACYLHYDROXYLAMINES. I. SYNTHESIS OF
O-BENZOYLHYDROXYLAMINE, by L. A. Carpino, C.
A. Giza, and B. A. Pepe. [1958] 14p. incl. table, refs.
(AFOSR-TN-58-759) (AF 18(603)114) AD 206327;
PB 137691 Unclassified

MAS.01:003; MAU.01:002;
MPP.01:002, 003

Also published in Jour. Amer. Chem. Soc., v. 81:
955-957, Feb. 1959.

O-Benzoylhydroxylamine has been synthesized by taking advantage of the ease of cleavage of the carbonyl-butoxy group. The hydrochloride was obtained analytically pure whereas the free base was found to be an unstable oil which suffered O- to N rearrangement of the benzoyl group. (Contractor's abstract)

MAS.01:003

Massachusetts U. Dept. of Chemistry, Amherst.

OXIDATIVE REACTIONS OF HYDRAZINES. IV. ELIMINATION OF NITROGEN FROM 1,1-DISUBSTITUTED-2-ARENESULFONHYDRAZIDES, by L. A. Carpino. Mar. 28, 1957 [5]p. incl. table, refs. (AFOSR-TN-57-146) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)114, Research Corp., New York, and Office of Ordnance Research under DA 19-059-ORD-2468) AD 126435 Unclassified

Presented at 130th National meeting of the Amer. Chem. Soc., Atlantic City, N. J., Sept. 18, 1956.

Also published in Jour. Amer. Chem. Soc., v. 79: 4427-4431, Aug. 20, 1957.

Alkaline degradation of 1,1-dibenzyl-2-benzenesulfonhydrazide leads to the formation of bibenzyls. The reaction is represented as proceeding through an intermediate formed by α -elimination of the elements of benzenesulfonic acid. A new method of introducing the very conveniently removed carbonyl-butoxy group is described involving acylation by t-butyl azidoformate.

MAU.01:002

Maudsley Hospital, London (Great Britain).

THE EFFECT OF ELECTRICAL STIMULATION OF THE HYPOTHALAMUS OR PITUITARY GLAND ON THYROID ACTIVITY, by G. W. Harris and J. W. Woods. [1958] [28]p. incl. illus, diagr. refs. (AF 61(514)953) Unclassified

Published in Jour. Physiol., v. 143: 246-274, Sept. 23, 1958.

Various areas in the hypothalamus and pituitary gland have been electrically stimulated for periods of 24 to 72 hr, using a remote control method, in 43 conscious rabbits. The effect of such stimulation on thyroid activity has been assessed by measuring the rate of release of ^{131}I -labelled hormone from the gland and by studies of the blood concentration of $\text{PB } ^{131}\text{I}$. Stimulation in rabbits with intact adrenal tissue results in increased thyroid activity if the electrode tips are

situated in the anterior part of the median eminence adjacent to the supraopticohypophyseal tract. Stimulation of more posterior and superior areas of the hypothalamus, and different regions of the pituitary gland, did not elicit thyroid activation. The mechanism of the change in thyroidal response after complete adrenalectomy was investigated in animals subjected to adrenal denervation or to adrenal cortical "blockade" with high doses of cortisone. The evidence indicates that it is removal of the adrenal cortex, rather than the adrenal medulla, which is effective in reversal of the thyroid response after adrenalectomy. Since stimulation of the hypothalamus is known to activate release of pituitary ACTH, and since adrenal corticoids have been shown to inhibit TSH secretion, it is suggested that the effect of adrenalectomy is to prevent a sudden rise of adrenal steroids in the blood simultaneous with the period of stimulation.

MPP.01:002

Max-Planck-Institut für Physik der Stratosphäre, Hechingen (Germany).

MEASUREMENTS OF THE ENERGY ABSORPTION IN RADIATION FIELDS OF ELECTRON SOURCES, by A. E. Grün. [1957] 19p. incl. diagr. refs. (Technical note no. 1) (AFOSR-TN-57-118) (AF 61(514)911) AD 120471 Unclassified

Abstract published in Aeronaut. Eng. Rev., v. 16: 142, June 1957.

The energy absorption $\alpha(z)$ of air in the radiation field of a special electron source was measured as a function of the penetration depth z (depth dose curve). As a measure of the absorption the luminescence of air was used. The electron source delivered an electron beam that was transferred from the vacuum into the air by dynamical pressure stages. The primary energy E_0 of the electrons was varied from 5 - 54 kev. A power law was found for the range R of the electrons as a function of E_0 . The measured function $\alpha(z)$, plotted against z/R and suitably normalized, show a remarkably little dependence of E_0 . The energy loss $-dE/ds$ of the electrons, taken from the measured curves, are in good accordance with BETHE's theory. (Contractor's abstract)

MPP.01:003

Max-Planck-Institut für Physik der Stratosphäre, Hechingen (Germany).

MEASUREMENT OF AIR DENSITY BY ELECTRON ABSORPTION, by A. E. Grün. Final technical rept. [1957] 9p. incl. diagr. (AFOSR-TN-57-58) (AF 61(514)911) AD 136515 Unclassified

Previous results (see item no. MPP.01:002) are

applied to the measurement of the air density by electron absorption. The main features of the measuring arrangement are a specially constructed electron source and a light detecting system which receives the luminescence radiation of the air excited by the electrons. The method can be used to measure normal air densities (ρ_0) down to $10^{-2}\rho_0$. This range is determined by the range of acceleration voltages with which the electron source can be operated.

MPS.03:001

[Max-Planck-Inst. für Strömungsforschung, Göttingen (Germany)]

RESEARCH ON INVESTIGATION OF THE INTERACTION OF SOUND AND TURBULENCE, by [W. Tellmien] [Annual] survey rept. Dec. 1, 1956-Nov. 30, 1957. [1958] 34p. incl. diagrs. (AFOSR-TN-58-236) (AF 61(514)1143) AD 154138 Unclassified

Investigation was made of the elementary process of scattering of sound by a vortex and of the dependence of the scattering properties of the characteristic parameters of the problem. Consideration is given to superposition of the effects of elementary scattering in a field of flow in which the vortices are statistically distributed due to an arbitrarily given distribution function controlling direction of the axis, size and circulation of the vortices. Arbitrary choice of the distribution function enables treatment of both isotropic and non-isotropic turbulence.

MED.02:001

Méditerranéen de Recherches Thermodynamiques, Nice (France).

[EXPERIMENTAL STUDY OF THE ARRESTED PRESSURE AND TEMPERATURE IN A FREE MOLECULAR SYSTEM] Etude expérimentale de la pression et de la température d'arrêt en régime moléculaire libre, by F. M. Devienne. [1957] 19p. incl. illus. diagrs. tables. (AFOSR-TN-57-82) (AF 61(514)930) AD 120428 Unclassified

A study is made of the heating and friction effects upon a missile in the ionosphere, where the atmosphere is rarefied such that the mean free course of the molecules is large in comparison to the dimension of the moving bodies. The experimental methods of measurement are: (1) the measurement of the mean free path flow in a cylindrical tube and (2) the use of a high-speed turning arm in a vacuum jar. The results selected are measurements of the elevations of temperature observed. Methods used and some results describe the measurements of the maximum retarding pressure.

MED.02:002

Méditerranéen de Recherches Thermodynamiques, Nice (France).

[EXPERIMENTAL STUDY OF THE STAGNATION TEMPERATURE IN A FREE MOLECULAR SYSTEM] Etude expérimentale de la température d'arrêt en régime moléculaire libre, by E. A. Brun and F. M. Devienne. [1957] [20]p. incl. diagrs. tables. (AFOSR-TN-57-83) (AF 61(514)930) AD 120429 Unclassified

Also published in Jour. Aeronaut. Sciences, v. 24: 403-406, 412, June 1957.

The object of this research is the measurement of the temperature of a small plate in rapid displacement in a free molecular flow normal to the velocity when the plate is thermally insulated. The permanent temperature elevation, that it presents in relation to the rarefied gas which surrounds it, is given by a formula derived by assuming that the velocity distribution is that of Maxwell. Two methods are used. A plate placed normally to a free molecular flow in a cylindrical tube and a fixed plate on a support insulated at the end from a high-velocity turning arm, with the plane of the plate containing the axis of rotation. The second method varies the pressure and velocity in a continuous fashion. A correction adjusting for heat exchange with the support is given. This correction is effected by an original method.

MED.02:003

Méditerranéen de Recherches Thermodynamiques, Nice (France).

STUDY OF STAGNATION TEMPERATURE AND PRESSURE IN A FREE-MOLECULAR FLOW REGIME, BY MEANS OF THE REVOLVING ARM METHOD, by F. M. Devienne. Mar. 1957 [102]p. incl. diagrs. tables. (AFOSR-TR-57-32) (AF 61(514)930) AD 126495 Unclassified

This report is divided into four parts. The first part gives the theory regarding stagnation pressure and also that concerning the rise in temperature of a plate moving perpendicular to its velocity. It is shown that for relatively small rises in temperature the influence of the rotational energy of the molecules of rarefied gas is generally negligible. In the second part the results of stagnation pressure measurements taken up to speeds a little above 150 m/s are discussed. The measurements were taken by means of ionization gauges of a special type. The third part gives the results concerning rise in temperature and measurements of the ratio $\frac{a}{c}$ and $\frac{a}{c}$

for plates of different kinds in different gases up to speeds slightly above 300 m/s. The gases used were dry air, helium, argon, carbon dioxide, methyl chloride and freon 12. These measurements were taken at different pressures and for speeds in general between

MED.03:001-003, MUF.01:007

50 and 300 m/s. They were taken by using the revolving arm method. The last part of the report is devoted to new series of measurements taken up to speeds definitely above 300 m/s. These measurements differ from the preceding ones in that the apparent value of the thermal emissivity ϵ' was determined by the aid of a new method which permitted calculation of the values of the accommodation coefficient α . For these measurements considerable alterations had to be made in the apparatus because great difficulties were encountered in achieving very high speeds.

MED.0° 001

Méditerranéen de Recherches Thermodynamiques, Nice (France).

CONSTRUCTION AND CALIBRATION OF A LOW DENSITY WIND TUNNEL, by F. M. Devienne, G. M. Forestier, and A. F. Roustan. Jan. 1958 [55]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-212) (AF 61(514)1126) AD 154113 Unclassified

A description is given of a low wind tunnel whose static pressure in the test chamber may, during the flow, vary between 0.1 μ and a few μ of Hg. The pumping in this wind tunnel is principally ensured by four large three-stage vacuum pumps. In order to calibrate the wind tunnel a preliminary study of the measurement of the impact pressure and of the corrections required by this measurement, is carried out with different pressure probes and for very different diameters. The results obtained after correction of the pressures lead us to admit that for a given nozzle and a static pressure in the range of 0.57 μ , the ratio of the impact pressure to the static pressure is given by the Superaerodynamic formula. The application of this formula leads us to the conclusion that the Mach number on the axis is very close to 4. The study of the field of pressure enables us to show that the velocity is fairly constant in the neighborhood of the axis in a cylinder having a diameter of approximately one third of that of the nozzle. (Contractor's abstract)

MED.03:002

Méditerranéen de Recherches Thermodynamiques, Nice (France).

THE REVOLVING ARM METHOD AND ITS APPLICATION TO RAREFIED GAS DYNAMICS AND AEROTHERMODYNAMICS, by F. M. Devienne. May 1958 [34]p. incl. illus. diagrs. (AFOSR-TN-58-769) (AF 61(514)1126) AD 201866; PB 136872 Unclassified

After having brought to mind the principle of the revolving arm method device, and the possibilities of measuring the stagnation temperature and the total pressure, the advantages and disadvantages of these methods are discussed. The essential advantage of the revolving

arm method is that the experimental conditions are perfectly determined. In particular the pressure and the temperature of the gas, as well as the speed of the arm are accurately determined. The revolving arm method is however limited by the fact that it is impossible to reach extremely high speeds. In the free molecular flow regime or the transition flow regime the revolving arm method can be applied without correction for Knudsen number values superior or equal to 0.6 in the case of dry air. This value is besides more or less the same for other gases with which studies of the phenomena in the vicinity of the arm, namely, argon and carbon dioxide were made. At higher pressures, which correspond to lower Knudsen numbers, it is necessary to make some corrections in order to keep account of the heating of gaseous layers in the vicinity of the arm. (Contractor's abstract)

MED.03:003

Méditerranéen de Recherches Thermodynamiques, Nice (France).

[FIRST INTERNATIONAL SYMPOSIUM ON THE AERODYNAMICS AND THERMODYNAMICS OF RAREFIED GASES. RESUMES OF CONFERENCES AND COMMUNICATIONS] Premier Symposium International sur l'Aerodynamique et l'Aerothermique des Gaz Rarefiés. Résumés des Conférences et Communications. July 2-5, 1958, 1v. incl. diagrs. refs. (AFOSR-TN-58-983) (AF 61(514)1126) AD 205874; PB 138625 Unclassified

The report contains 30 resumes of the conferences and papers presented at the symposium. Some general aspects of rarefied gases dealt with are (1) techniques of measurement, (2) Boltzmann, Boltzmann-Maxwell, and Boltzmann-Hilbert integral equations, (3) kinetic and slip flow theories, (4) free and nearly-free molecule flow, (5) magnetic boundary layers and suspension, (6) aerodynamics, (7) thermodynamics, and (8) plasmadynamics.

MUF.01:007

Miami U., Coral Gables, Fla.

RETRACTS FROM NEIGHBORHOOD RETRACTS, by W. L. Strother and L. E. Ward, Jr. Apr. 30, 1957 [8]p. incl. refs. (Rept. no. 8) (AFOSR-TN-57-227) (AF 18(600)1449) AD 126525 Unclassified

Also published in Duke Math. Jour., v. 25: 11-14, Mar. 1958.

A compact Hausdorff space X is called a CAR* (or CANR*) if it is a retract (or neighborhood retract) of a Tychonoff cube. If $S(X)$ is a space of closed subsets of an X which is CANR*, then $S(X)$ has a fixed point property and if X is metric, then $S(X)$ is CAR*. It is conjectured that the metric condition in the last statement can be dropped. The following theorems are proved: Theorem 1. Let X

MUF.01:008, 009; MUF.02:001-004

be a connected metric space. If X is a CANR*, then $S(X)$ is a CAR*. Theorem 2. If X is a CANR*, then $S(X)$ is a CANR*. Theorem 3. If X is a connected CANR*, then $S(X)$ has the fixed-point property. Analogies between neighborhood retracts and the null-homotopic fixed-point property suggest the question of equivalence between the fixed-point property in $S(X)$ and the null-homotopic fixed-point property in X .

MUF.01:008

Miami U., Coral Gables, Fla.

FIXED POINTS, by W. L. Strother. [Final] technical rept. June 1, 1955-Sept. 30, 1958 [24]p. incl. refs. (AFOSR-TR-58-142) (AF 18(600)1449) AD 204551
Unclassified

The strong bond is exploited which exists among functions, M -functions, and the space of closed subsets as a tool for proving fixed point theorems. Specific problems are: (1) if X is a CAR, is $S(X)$ a CAR?; (2) classify the functions, $f: S(X) \rightarrow S(Y)$; (3) conditions on X , Y and the continuous M -function $F: X \rightarrow Y$ so that there exists a continuous trace $f: X \rightarrow Y$ of F ; (4) conditions on X so that there exists a continuous function $f: S(X) \rightarrow X$ such that, for each element A in $S(X)$, $f(A) \in A$; and (5) for what spaces X and functions $f: S(X) \rightarrow S(X)$ will there exist fixed points. CAR is the retract of a Tychonoff cube.

MUF.01:009

Miami U., Coral Gables, Fla.

MULTI-VALUED FUNCTIONS AND PARTIAL ORDER, by C. E. Capel and W. L. Strother. [1958] [7]p. (AF 18- (600)1449) AD 204551
Unclassified

Published in Portugal. Math., v. 17: 41-47, 1958.

Some results are presented on traces and fixed points for multi-valued functions on spaces which have a continuous partial order. In Section 1 some basic definitions are given. In Section 2 a fairly general result is presented to show when a continuous, multi-valued function will have a trace. Some examples then show how this leads to fixed point theorems. In Section 3 it is shown that a weakly continuous, point-connected, multi-valued function on a tree has a fixed point. This is an order-theoretic version of a theorem of Wallace where tree is defined in a combinatorial sense. (Contractor's abstract)

MUF.02:001

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

THE CONTINUITY POSTULATE FOR MARKOV

PROCESSES. ABSTRACT SPACE CASE, PART I, by D. G. Austin and R. V. Chacon. Sept. 27, 1957, 19p. (Rept. no. 9, pt. 1) (AFOSR-TN-57-586) (AF 49(638)-184) AD 136575a
Unclassified

The continuity properties of stationary Markov transition functions are defined on an abstract space X . A number of conditions weaker than Doob's continuity postulate are found to be sufficient to insure that the transition functions are continuous. A necessary and sufficient condition for this result is obtained and some examples are given to show that the results are the best possible.

MUF.02:002

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

THE KOLMOGOROV DIFFERENTIAL EQUATIONS, by D. G. Austin. Sept. 27, 1957, 31p. incl. refs. (Rept. no. 9, pt. 2) (AFOSR-TN-57-587) (AF 49(638)184) AD 136575b
Unclassified

In the discrete state case several necessary and sufficient conditions for the Kolmogorov differential equations are established. Some progress is made on the problem of higher order derivatives and some asymptotic results are obtained.

MUF.02:003

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

STOCHASTIC PROCESSES WITH DISCRETE STATE SPACE, by D. G. Austin. [1958] [76]p. incl. refs. (AFOSR-TN-58-967) (AF 49(638)184) AD 205779
Unclassified

A study is made of stochastic processes with state space, the positive integers; time-parameter, the non-negative real line; and with conditional probabilities that depend only on the increment of time. That the process is Markovian is assumed. Sample function properties and analytic properties of conditional probabilities are developed without the Markov hypothesis, so that the exact effect of the Markov hypothesis on these properties will be in evidence. The results obtained are grouped under the following general headings: measure theoretic results, real and strong form continuity properties of the sample functions, the strong Markov property, the entrance boundary problem, and analytic properties of the transition matrix. A discussion follows on the significance of the results obtained.

MUF.02:004

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

A NEW PROOF OF THE STRONG MARKOV THEOREM OF CHUNG, by D. G. Austin. [1958] [4]p. (AF 49(638)-184) AD 205779
Unclassified

MUF.02:005; MUF.03:001-003

Published in Proc. Nat'l. Acad. Sciences, v. 44: 575-578, June 1958.

The author has obtained an important part of Chung's basic result by a simple approximation procedure, at the price of losing Chung's detailed analysis of the transition probabilities from time α to later times, which yields the absolute probability distribution of the $y(t)$ process.

MUF.02:005

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

ON CONTINUITY OF TRANSITION FUNCTIONS, by D. G. Austin, R. M. Blumenthal, and R. V. Chacon. [1958] [9]p. [AF 49(638)184] Unclassified

Published in Duke Math. Jour., . 25: 533-541, Sept. 1958.

The authors consider the smoothness of Markov transition functions $P_t(a, B)$ in their dependence on $t \geq 0$ for fixed (points) a and (measurable sets) B . A sample result is that, for fixed a , $P_t(a, B)$ is continuous from the right in $t \geq 0$ for each (measurable) B if and only if it possesses a density function, measurable in the pair (t, b) . (Math. Rev. abstract)

MUF.03:001

Miami U. Dept. of Physics, Coral Gables, Fla.

RELATIVISTIC EFFECTS IN THE COHESIVE ENERGIES OF THE ALKALI METALS, by J. Callaway, R. D. Woods, and V. Sirounian. May 1957 [21]p. incl. diagr. tables, refs. [Technical rept. no. 4] (AFOSR-TN-57-208) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)62 and Office of Naval Research under [Nonr-84006]) AD 126505 Unclassified

Also published in Phys. Rev., v. 107: 934-939, Aug. 15, 1957.

The relativistic corrections to the cohesive energies of the alkali metals are studied from two points of view. In the first, perturbation theory is applied to the second approximation to the Dirac equation. Calculations are made for potassium and cesium. The limitations of this approach are discussed. In the second, the quantum defect method is extended to include almost all relativistic effects. A relativistic analog of Bardeen's expression for the effective mass ratio is derived. Application is made to cesium. (Contractor's abstract)

MUF.03:002

Miami U. Dept. of Physics, Coral Gables, Fla.

INFRARED OPTICAL CONSTANTS OF GALLIUM ARSENIDE (Abstract), by A. Perlmutter. [1957] [2]p. [AF 49(638)62] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 66-67, Jan. 30, 1957.

The transmission and reflectivity of a sample of n-type GaAs have been measured in the region from 0.86 to 25μ . The free carrier absorption is found to be proportional to the square of the wavelength, beginning about 7μ , in agreement with the Drude and Kronig theory. The effective mass of the conducting electrons, which is determined from these data and the carrier concentration ($6.9 \times 10^{17} \text{ cm}^{-3}$ at room temperature), is found to be 0.075 or about double the value reported from thermoelectric measurements. Measurements of the reflectivity as a function of the wavelength will also be described. The optical energy gap was found to be about 1.35 ev, a value which is about equal to that found previously. A long tail at the absorption edge masks the possible effect of indirect transitions.

MUF.03:003

Miami U. Dept. of Physics, Coral Gables, Fla.

EFFECTIVE MASS OF ELECTRONS IN GALLIUM ARSENIDE, by L. C. Barcus, A. Perlmutter, and J. Callaway. Mar. 5, 1958 [8]p. incl. diagr. (AFOSR-TN-58-152) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)62 and Office of Naval Research) AD 152176 Unclassified

Presented at annual meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 30, Jan. 29, 1958.

Also published in Phys. Rev., v. 111: 167-168, July 1, 1958.

The optical properties of n type gallium arsenide have been studied by a method of reflection of polarized light from a surface of the sample. The dielectric susceptibility has been determined from measurements of the index of refraction $n(\lambda)$ and the extinction coefficient K in the wavelength region between 0.78 and 22μ . The susceptibility has been used to calculate the effective mass of the conduction electrons. It has been found that K has a value of 0.1 or less throughout the wavelength range used and that $n^2(\lambda) = 11.06 - c\lambda^2$. The value of the

MUF.03:004 - MUF.03:008

effective mass $0.43 \pm .005 m_0$ obtained supports the hypothesis that the minimum of the conduction band is at the center of the Brillouin zone.

MUF.03:004

Miami U. Dept. of Physics, Coral Gables, Fla.

ELECTRON ENERGY BANDS IN SODIUM, by J. Callaway. June 1958 [13]p. incl. diagr. tables, refs. (AFOSR-TN-58-503) (AF 49(638)62) AD 158314
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 192, May 1, 1958.

Also published in Phys. Rev., v. 112: 322-325, Oct. 15, 1958.

The potential energy of a valence in sodium is represented by the function $V(r) = -2/r + Ae^{-\beta r}/r$. The second term, which is repulsive in character, represents the effect of the core electrons. Values for A and β are determined from spectroscopic data. Energy levels of predominantly s and p symmetry are determined at four points of the Brillouin zone. (Contractor's abstract)

MUF.03:005

Miami U. Dept. of Physics, Coral Gables, Fla.

FOURIER COEFFICIENTS OF CRYSTAL POTENTIALS, by J. Callaway and M. L. Glasser. May 1958, 12p. incl. tables. (AFOSR-TN-58-504) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)62 and Office of Naval Research) AD 158315
Unclassified

Also published in Phys. Rev., v. 112: 73-77, Oct. 1, 1958.

A method is developed for the calculation of the Fourier coefficients of the electrostatic potential of a given distribution of valence electrons in a solid. The valence electron wave functions are expressed as combinations of orthogonalized plane waves. The treatment takes full account of the nonspherical character of the atomic polyhedron. Application is made to lithium. (Contractor's abstract)

MUF.03:006

Miami U. Dept. of Physics, Coral Gables, Fla.

STUDIES OF ELECTRON ENERGY BANDS, by J.

Callaway. Final technical rept. June 1958, 14p. incl. table, refs. (AFOSR-TR-58-98) (AF 49(638)62) AD 162172
Unclassified

A summary of the work done under this contract is presented and a list of the publications is included. The relativistic effects in the calculations of the cohesive energies of the alkali metals have been studied and reported upon. The dependence of the results of band calculations on the crystal potential assumed has been studied with respect to the general form of the bands and the specific calculations using a pseudo-potential for calculations of energy bands in sodium. Further information on the dependence of energy bands with respect to the crystal potential assumed can be obtained from study of materials which have similar crystal structure but different atomic constituents. The effective mass of gallium arsenide has been determined and the value obtained indicates that in GaAs the band minimum is at the center of the Brillouin zone. Studies on the Fourier analysis of crystal potentials by means of an orthogonal plane wave method and the existence of surface eigenstates for a finite one-dimensional lattice have been carried out.

MUF.03:007

Miami U. Dept. of Physics, Coral Gables, Fla.

SURFACE STATES IN LINEAR CHAINS, by H. A. Brown. Final technical rept. Sept. 1958 [43]p. incl. diagr. (AFOSR-TR-58-128) (AF 49(638)62) AD 203493
Unclassified

The additional allowed energy levels introduced in the solution of a finite one-dimensional lattice as compared with the states allowed in a non-terminating lattice have been studied. The potential in each cell is assumed to be symmetric about the center of each cell. It is found that the surface states are possible even in the case in which there is no crossing of energy bands. The generalization of the Bloch theorem to include a complex wave vector has been found to be not justified in accounting for the finite lattice. It has been concluded that the restriction of using the generalized Bloch function in this case has caused the error in the assertion of the impossibility of surface states except when bands cross. The only restriction now imposed is that a surface state cannot pass through a cross-over point for the bands. The surface states have been shown to occur as singlets rather than as pairs as previously asserted.

MUF.03:008

Miami U. [Dept. of Physics] Coral Gables, Fla.

SELF-CONSISTENCY IN BAND CALCULATIONS (Abstract), by M. L. Glasser and J. Callaway. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)62] and Office of Naval Research) AD 162172
Unclassified

MUO.01:002-004; MSU.01:001

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 146, Mar. 27, 1958.

It has been a usual procedure in band calculations to include the effects of the valence electron distribution by assuming it to consist of overlapping spheres of uniform charge density. This is not self-consistent, and a procedure has been developed within the scope of the OPW method, for taking the symmetry and radial dependence of the distribution into account. A valence charge distribution in the unit cell is obtained from an initial estimate of the electron wave functions and Poisson's equation is used to obtain the Fourier coefficients of the desired potential. As a test, the procedure has been applied to silicon and the results compared with those obtained from a spherical approximation.

MUO.01:002

Miami U., Oxford, Ohio.

X-RAY STUDIES OF METAL HALIDES IN THE MELT AND IN SOLUTION (Abstract), by H. L. Ritter. [1956] [1]p. [AF 18(600)485] Unclassified

Presented at the Southwide Chemical Conf., Memphis, Tenn., Dec. 8, 1956.

The calculation of a radial distribution curve from Debye-Scherrer x-ray patterns of liquids by the method of Warren, Krutter, and Morningstar has been carried out for certain metal halides in the fused state and in solution. In many cases a clear insight into the structure of the liquid is afforded. Thus fused aluminum chloride appears to be composed of Al_2Cl_6 molecules of determinable structure; indium iodide of similar molecules either much more poorly defined or partly dissociated into monomers or ions; tin (IV) iodide of tetrahedral monomeric molecules; and fused cadmium iodide is a curious transition between the known structures of the crystalline and gaseous state. In solution, SnI_4 in benzene and CdI_2 in water are molecular, the latter showing no change on dilution. CsI in water shows little evidence of association; BaI_2 and LaI_3 in water show considerable structure due either to ion association or hydration.

MUO.01:003

Miami U., Oxford, Ohio.

AN X-RAY STUDY OF WATER SOLUTIONS OF CADMIUM IODIDE, by G. R. Simmons and H. L. Ritter. [1958] [2]p. (AFOSR-TN-58-40) (AF 18(600)485) AD 148081 Unclassified

Patterns of x-ray diffraction have been obtained for water solutions of cadmium iodide having various concentrations of which 0.042 mol ratio of CdI_2/H_2O is a nearly saturated solution. Using crystal-monochromated Mo-K α radiation, three exposures were made of each solution, each ranging from 60 to 80 hr. Radial distribution curves for the solutions were computed by means of the Fourier analysis of Warren. The great visual difference in diffraction patterns of CdI_2 solutions as compared with BaI_2 solutions indicates that there is a considerable difference in solute structure. A difference anticipated by knowledge of the fact that CdI_2 is much less ionized than BaI_2 .

MUO.01:004

Miami U., Oxford, Ohio.

AN X-RAY STUDY OF WATER SOLUTIONS OF BARIUM IODIDE, by A. K. Prince, P. Bender, and H. L. Ritter. [1958] [21]p. incl. illus. table. (AFOSR-TN-58-1071) [AF 18(600)485] AD 207240 Unclassified

Presented at meeting of the Phys. and Inorg. Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Abstract published in 131st meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 44-R-45-R.

X-ray patterns have been obtained for different concentrations of barium iodide solutions in water. Radial distributions were derived by the method of Warren, Krutter, and Morningstar, all showing significant features in the regions of 2.8, 3.7 to 4.0, and 5.0 to 6.5A. The first is identified with the O-O distance in water and the Ba-O distance in hydrated Ba^{++} . The shift of the position of this feature with concentration and the excess of its associated area over that of the corresponding peak in water make possible estimates of hydration numbers and distances. A hydration distance of 2.6A and hydration numbers ranging from 7 in saturated solution to 12 in dilute solution are consistent with curves observed in this study. Peaks near 3.8A range monotonically from 3.7A in saturated to 4.0A in dilute solution. These distances are identified with the Ba-I distance in crystalline barium iodide and provide evidence of ion association in solution. Decrease in peak prominence and shift in peak position agree with the notion that ion association should decrease with concentration. Broader humps in the 5 to 6.5A region are explained on the basis of loose, incipient ion clusters.

MSU.01:001

Michigan State U. Dept. of Physics and Astronomy, East Lansing.

THE USE OF A SAMARIUM LOADED LIQUID

MSU.02:001 - MSU.02:004

SCINTILLATOR FOR THE DETERMINATION OF THE HALF-LIFE OF Sm^{147} , by G. B. Beard and W. H. Kelly. June 18, 1958 [7]p. incl. diagrs. (AFOSR-TN-58-497) (AF 49(638)10) AD 158307; PB 135816

Unclassified

Also published in Nuclear Phys., v. 8: 207-209, Sept. 1958.

An investigation of the use of metal loaded organic liquid scintillators for the study of long lived alpha emitters has been carried out. The method was checked using a samarium loaded scintillator. A specific activity corresponding to a half-life of $(1.28 \pm 0.04) \times 10^{11}$ yr for the alpha decay of Sm^{147} was found. This is in agreement with the published half-life measured using a different technique. (Contractor's abstract)

MSU.02:001

Michigan State U. Dept. of Physics and Astronomy, East Lansing.

RESIDUAL RESISTIVITY OF COPPER AND SILVER ALLOYS. THE PERIOD DEPENDENCE, by F. J. Blatt. June 15, 1957, 10p. diagrs. tables, refs. (AFOSR-TN-57-315) (AF 49(638)70) AD 132386 Unclassified

Also published in Phys. Rev., v. 108: 285-290, Oct. 15, 1957.

Attention is given to the fact that polyvalent impurities of the Ag period of the periodic table give rise to a smaller residual resistivity in both Cu and Ag than do polyvalent impurities belonging to the Cu period. An explanation of this experimental result is presented which is based on a modification of the Friedel sum rule suggested by Harrison by which one may take lattice distortion into account. The calculated results reflect the qualitative features of the experimental data and, moreover, lead to better quantitative agreement between theory and experiment than previous calculations based on the free electron model. The occurrence of a similar period dependence of the thermoelectric power of these alloy systems is suggested and is being investigated.

MSU.02:002

Michigan State U. Dept. of Physics and Astronomy, East Lansing.

RESIDUAL RESISTIVITY OF GOLD ALLOYS: DEPENDENCE ON PERIODIC TABLE, by F. J. Blatt. Aug. 28, 1957 [12]p. incl. diagrs. tables, refs. (AFOSR-TN-57-503) (AF 49(638)70) AD 136493 Unclassified

Also published in Phys. Rev., v. 108: 1204-1206, Dec. 1, 1957.

The residual resistivities, $\Delta\rho$, of dilute alloys of Au were calculated by a method suggested earlier (item no. MSU.02:001). With the exception of those for Au-Cu and Au-Ag alloys, the calculated resistivities agreed reasonably well with the observed residual resistivities. The numerical results differed from the observed resistivities by significant amounts, especially for $Z = 2$, where Z is the valence difference between solute and solvent atoms. The dependence of $\Delta\rho$ on the row of the periodic table which the solute occupies is reflected in the calculated values for the ratios $\text{Au}(\text{Cu})/\text{Au}(\text{Ag})$. The influence of Z and of lattice strain due to the solute may be taken into account by the modification of the Friedel sum condition (Advances in Phys., v. 3: 446, 1954), except when $Z = 0$ where differences in the core potential are important.

MSU.02:003

Michigan State U. Dept. of Physics [and Astronomy] East Lansing.

THE MAGNETIC SUSCEPTIBILITY OF METALS, by F. J. Blatt. Sept. 12, 1958 [3]p. incl. table. (AFOSR-TN-58-287) (AF 49(638)70) AD 154191 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 6: 301-303, Aug. 1958.

A discrepancy has been found to exist between the theoretical values for the diamagnetic susceptibility of the conduction electrons in the close-packed monovalent metals and the values obtained by subtracting the experimental value for the susceptibility of the electronic spin from the total susceptibility. An interaction susceptibility is proposed similar to that suggested by Jones (Proc. Roy. Soc. London, A240: 321, 1957) for the interaction of the conduction electrons and the lattice vibrations. The correction afforded by this extra susceptibility has the right sign and the magnitude necessary to bring calculated and experimental results into substantial agreement is not unreasonably large.

MSU.02:004

Michigan State U. [Dept. of Physics and Astronomy] East Lansing.

DIPole SCATTERING IN SEMICONDUCTORS, by R. R. Sloum. June 23, 1958, 5p. (AFOSR-TN-58-472) (AF 49(638)70) AD 158283 Unclassified

Presented at meeting of the Amer. Phys. Soc., St. Louis, Mo., Nov. 29-30, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 346, Nov. 29, 1957.

Recent work on the interaction of defects in semiconductors has suggested that ion-pairs are formed and that

MIC. 14:001; MIC. 15:001-003

dipole scattering effects in these substances should be considered. Using a formulation due to Massey for scattering centers of polar symmetry, the cross-section for dipole scatterers has been calculated, and subsequently a relaxation time obtained. Comparison of this relaxation time with that of Conwell and Weisskopf for ionized impurities and that for neutral impurities showed that over all temperature ranges, the dipole scattering is negligible with respect to both. The relaxation time for the dipole scattering process exhibits an energy dependence of $E^{-1/2}$. (Contractor's abstract, modified)

MIC. 14:001

Michigan U. Dept. of Aeronautical Engineering, Ann Arbor.

FLOW FIELD OF A BUNSEN FLAME, by M. S. Uberoe, A. M. Kuethe, and H. R. Menkes. [Final rept.] May 14, 1957 [29]p. incl. illus. diags. (AFOSR-TN-58-95) (AF 18(600)1512) AD 132444 Unclassified

Also published in Phys. Fluids, v. 1: 150-158, Mar.-Apr. 1958.

The flow field of a 2-dimensional Bunsen flame is examined by approximating the zone of combustion by a surface of discontinuity across which the density drops and normal velocity increases. Even though the flow of unburned gases is potential, the flow of the burned gases is always rotational which is therefore not amenable to complete analysis. Interaction of flame shape and flow field is obtained analytically and experimentally. The entire flow field of unburned and burned gases is mapped by taking stroboscopic photographs of small particles suspended in the combustible gases. The measured flow field is considered in the light of the above analysis. (Contractor's abstract)

MIC. 15:001

Michigan U. Dept. of Mathematics, Ann Arbor.

ON CURVATURE AND CHARACTERISTIC OF HOMOGENEOUS SPACES, by H. Samelson. Jan. 1958, 18p. (AFOSR-TN-57-572) (AF 49(838)104) AD 136557 Unclassified

Also published in Mich. Math. Jour., v. 5: 13-18, Jan. 1958.

Let G be a compact connected Lie group, U a closed subgroup of G , and $M = G/U$ be the homogeneous space formed by the left cosets of U . A simple geometric proof is given of the fact that all values of the sectional Riemannian curvature of M , in the induced Riemannian metric, are nonnegative. A new proof is given of the fact that the Euler-Poincaré characteristic $\chi(M)$ of M is non-negative and is positive exactly if U is of maximal rank.

MIC. 15:002

Michigan U. Dept. of Mathematics, Ann Arbor.

POINCARÉ DUALITY IN HOMOLOGY MANIFOLDS, by F. A. Raymond. [1958] [71]p. incl. diags. refs. (AFOSR-TN-58-457) (AF 49(838)104) AD 158264 Unclassified

The problem is studied which considers the conditions which must be imposed on a topological space X such that there exists an isomorphism between the p -dimensional terms of the homology sequence of X and the $(n-p)$ -dimensional terms of the Čech cohomology sequence of X such that naturality holds. A suitable homology is defined on the space like a singular homology and the Poincaré and Alexander-Pontrjagin duality isomorphisms are studied for combinatorial manifolds of dimension n . Chapters 1 and 2 give a very general concept of chains and homology. The definition of homology manifolds and the proofs of several theorems are given, which enable the uses of the algebraic duality cohomology theorem of H. Cartan. The problem of the dimension of a closed set without any interior is resolved in Chapter III by the characterization of interior and boundary points of closed subsets of homology manifolds.

MIC. 15:003

Michigan U. Dept. of Mathematics, Ann Arbor.

THE ACTIONS OF THE GROUPS $SO(3)$ AND $Sp(1)$ ON THE SPHERE S^4 AND S^5 , by R. W. Richardson. [1958] 81p. incl. refs. (AFOSR-TN-58-488) (AF 49(838)104) AD 158296 Unclassified

All actions to within equivalence of $SO(3)$, the group of proper orthogonal transformations of E^3 , and $Sp(1)$, the group of unit quaternions, are considered on the 4-dimensional sphere, S^4 , and the 5-dimensional sphere, S^5 . No differentiability assumptions are made. Restriction was made to cases in which there exists a 3-dimensional orbit. Two theorems are proved which characterize the orbit space if a compact Lie group acts on the n -sphere with $(n-1)$ - or $(n-2)$ -dimensional orbits.

Actions of $SO(3)$ and $Sp(1)$ on S^4 are all linear. Within equivalence, there are exactly 2 actions of $SO(3)$ on S^4 and one effective action of $Sp(1)$ on S^4 . There is only one action of $Sp(1)$ on S^5 which is effective and it is linear. There are, at most, 3 such actions of $SO(3)$ on S^5 . Two of them are linear. An indecisive theorem regarding the possible nonlinear action, states that there is, at most, one action of $SO(3)$ on S^5 , such that all orbits are either 3-dimensional or fixed points. Such an action exists only if S^5 is homeomorphic to the double suspension of $SO(3)/H_1$.

MIC.15:004, 005; MIC.18:001

MIC.15:004

Michigan U. [Dept. of Mathematics] Ann Arbor.

ACYCLIC CONTINUA IN THE PLANE AND QUASI-COMPLEXES, by J. E. Keisler. July 1958, 15p. (AFOSR-TN-58-656) (AF 49(838)104) AD 182187; PB 138980 Unclassified

Quasi-complexes, a class of spaces to which the Lefschetz fixed point formula applies, are related to finite Euclidean complexes, all parallelotopes, and all snake-like continua. It is demonstrated that there are acyclic plane continua, possessing the fixed point property, which are not quasi-complexes, even in the event of a T-like plane continuum. A covering is a finite open covering and an ϵ -covering of a metric space is a covering such that the diameter of each element of the covering is less than ϵ . For coverings A_1, A_2 such that A_1 refines A_2 ($A_1 > A_2$), $N(A_1)$ denotes the complex which is the nerve of the covering A_1 and $\pi(1,2)$ denotes one of the projection chain maps $\pi(1,2):N(A_1) \rightarrow N(A_2)$ induced by the inclusion map.

For s an element of the covering A , Sta is the union of all those elements of A which intersect a . A_1 star refines A_2 ($A_1 \gg A_2$) if the covering C , whose elements are the sets Sta for all a which are elements of A_1 , refines A_2 . Further definitions are given and proofs of lemmas and corollaries introduced.

MIC.15:005

Michigan U. Dept. of Mathematics, Ann Arbor.

THE TORSION OF SHAFTS OF VARYING CIRCULAR CROSS SECTIONS, by H. L. Hunzeker. Oct. 1958, 85p. incl. diagrs. refs. (AFOSR-TN-58-738) (AF 49(838)104) AD 201504; PB 137839 Unclassified

The torsion of a shaft of varying circular cross sections is considered. The problem is the following: The elastic body under consideration is a solid of revolution with plane ends perpendicular to the axis of revolution, and the body is twisted by twisting couples applied to the ends. It is desired to find the components of stress, strain, and displacement throughout the body. The chapters discuss the following topics: I. The fundamental equations of elasticity are considered and reduced for the case of the torsion of a shaft of varying circular cross sections, using a tensorial approach from Hay. II. The torsion of a hollow prolate ellipsoidal shaft and of a shaft of nearly uniform cross sections with an arbitrary prolate ellipsoidal cavity is considered for non-orthogonal coordinates. III. Hay's analysis obtains the solution to the Saint Venant torsion problem for a shaft of nearly uniform cross sections with an arbitrary symmetrically located oblate ellipsoidal cavity. IV. A re-

sult is given for the torsion of a shaft bounded by a portion of an arbitrary hyperboloid of revolution of two sheets, in classical elliptical coordinates. V. Consideration is given to the torsion of a general shaft of varying circular cross sections.

MIC.16:001

Michigan U. [Dept. of Mathematics] Ann Arbor.

ASYMPTOTIC THEORY OF SECOND ORDER DIFFERENTIAL EQUATIONS WITH TWO SIMPLE TURNING POINTS, by N. D. Kazarinoff. [1958] [22]p. incl. diagrs. (AFOSR-TN-58-485) (AF 49(838)192) AD 219117 Unclassified

Also published in Arch. Rational Mech. Anal., v. 2: 129-150, 1958.

The author considers second order ordinary linear differential equations of the form

$$(1) \quad d^2y/ds^2 - \lambda^2 P(s, \lambda)y = 0,$$

where $P(s, \lambda) = \sum_{j=0}^{\infty} p_j(s)\lambda^{-j}$ is analytic in s in a region D of the complex plane s and in λ for $|\lambda| > N$, and where $p_0(s)$ has exactly two simple zeros α, β in the interior of D (two turning points in the terminology now well known after the work of Langer). As in Langer's theory, which has a great bearing in the present paper, the problem is to find asymptotic expansions for the solutions of (1) uniformly valid in D for $|\lambda| \rightarrow +\infty$. The equation (1) is transformed first into an analogous equation of the form

$$(2) \quad d^2u/dz^2 - \lambda^2 Q(z, \lambda)u = 0,$$

where $Q(z, \lambda) = \sum_{j=0}^{\infty} q_j(z)\lambda^{-j}$, $q_0(z) = z^2 - 1$, and $Q(z, \lambda)$ is analytic in a region R containing the two turning points $z = \pm 1$ in its interior. The main point consists in taking as "leading terms" of the asymptotic expansion for (2), or "first approximation", the solutions of the Weber equation

$d^2v/dt^2 + [v/2 - t^2/4]v = 0$, which is here transformed into $d^2v/dt^2 - \lambda^2[(z^2 - 1) + \lambda^{-1}c + \dots]v = 0$, by a convenient change of variables and choice of the parameter. Finally, as in Langer's theory, successive approximations are defined, the n th approximation satisfying an equation of the same form, where the expression in brackets coincides with $Q(z, \lambda)$ up to the terms of degree $n - 1$ in λ . Previous results of Langer and McKelvey are used. It is then proved that the n th approximation is a valid asymptotic expansion to $n + 1$ terms of solutions of (2). Specific hypotheses are made during the process which cannot be referred to here. The behavior of the solutions of equation (2) are known inasmuch as one knows the behavior of the Weber functions, which are the leading terms of the expansion. In particular, results of Erdelyi, Kennedy and McGregor

MIC.17:001 - MIC.17:003

are used. An algorithm is given to determine recursively the terms of the asymptotic expansions of these Weber functions. (Math. Rev. abstract)

MIC.17:001

Michigan U. Dept. of Physics, Ann Arbor.

PHOTOGRAPHIC SEQUENCE EXPOSURE EXPERIMENT, by J. H. Enns and E. Katz. Feb. 2, 1957 [7]p. incl. illus. diagrs. tables. (AFOSR-TN-57-53) (AF 49-638)69; continuation of AF 18(600)750 AD 115092
Unclassified

Also published in Jour. Opt. Soc. Amer., v. 47: 758-764, Aug. 1957.

An instrument is described which has been built for the automatic recording of sequence exposures on 4 x 10-in. photographic plates. Twelve shutter slides are independently timed so that on one plate up to 384 4 x 5-mm rectangles can be uniformly exposed to high and low intensity radiation. The present design is for an intensity ratio of 100:1, where both intensities are below optimum. With minor modifications the instrument can be converted to operate at other intensity ratios. The densitometer readings are checked from calibration strip data placed adjacent to the sequence exposures. The corrected data, following conversion to Seidel values, are plotted as families of characteristic curves, with the sequence exposure ratio as the constant parameter. Isodense loop data are read from the curves at the intersection with a line drawn parallel to the exposure axis. A theoretical discussion of isodense loops is presented which is based on the hypothesis that for isodense exposures the probability of rendering the last grains developable must be equal. It is shown how this method should yield the limiting slope of the low intensity failure curve and the minimum number of quanta absorbed by the average grain to become developable. Preliminary results presented here for Eastman Kodak Emulsion Type 33 are within expectation.

MIC.17:002

Michigan U. [Dept. of Physics] Ann Arbor.

PHOTOGRAPHIC EMULSION STUDIES BY THE SEQUENCE EXPOSURE EXPERIMENT (Abstract), by J. H. Enns and E. Katz. [1958] [1]p. [AF 49(638)69]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 100, Mar. 27, 1958.

The basic principles of the photographic sequence experiment are reviewed briefly, and experimental data for

several emulsion types are presented and discussed. The results show that the just developable grain of a commercial emulsion, color-sensitized in the blue, is a perfect (or nearly so) absorber of all incident photons at 4358A. More extensive data (varying average grain size, total and internal image development) is presented for a pure silver bromide emulsion of minimum sulfur sensitization. An interesting result for this emulsion type is, among other things, an increase in the absorbed photons determined for the just developable grain with increasing grain size or increasing sensitivity. This effect is discussed on the basis of dispersed latent image formation due to an increase in the number of effective trapping centers per grain.

MIC.17:003

Michigan U. Dept. of Physics, Ann Arbor.

GALVANOMAGNETIC CONSTANTS OF BISMUTH BETWEEN 120° AND 300°K, by E. Katz and W. Tantraporn. [1958] [9]p. incl. tables. [AF 49(638)69]
Unclassified

Published in Proc. Internat'l. Conf. on Electronic Properties of Metals at Low Temperatures, Geneva, N. Y. (Aug. 25-29, 1958), Schenectady, N. Y., General Electric Research Lab., 1958, p. 141-149.

The effect of a weak magnetic field \vec{B} on the components p_{ij} of the electrical resistivity tensor is described by a series of constants, called brackets, which have been enumerated systematically by Kao and Katz:

$$p_{ij}(\vec{B}) = \sum_{n=0}^{\infty} \sum_{m=0}^n \sum_{p=0}^m (m-p, p, n-m) B_1^m B_2^p B_3^{n-m}$$

The values of all brackets up to terms corresponding to the fourth power of B ($n \leq 4$) were measured by W. Tantraporn for single crystals of bismuth in the temperature range 120° - 300°K. Moreover the temperature dependence of the brackets with $n = 5, 6$ was established for a few cases. Experimental procedures are discussed. The temperature dependences found do not fit conventional trial functions but are well described by the empirical formula

$$\{n\} = T \Gamma e^{-\beta_n \sqrt{T}} \text{ for } n \leq 4.$$

Here Γ differs for each bracket but β_n only depends on n . The latter feature enabled us to obtain β_n also for $n = 5, 6$. It is found that $\beta_n \sim \frac{2n}{n+4}$ for $n \leq 6$.

Comparison with results of other authors is discussed. (Contractor's abstract)

MIC. 04:002; MIC. 05:004;
MIC. 06:005, 006

MIC.04:002

Michigan U. [Engineering Research Inst.] Ann Arbor.

STUDIES OF TRANSITION TO TURBULENT FLOW IN A TUBE, by A. M. Kuethe and K. R. Raman. [1957] 2p. [AF 18(600)350] Unclassified

Also published in Proc. Ninth Internat'l. Congress of Appl. Mech., Brussels (Belgium) (Sept. 5-13, 1956), v. 3: 349, 1957.

The work is a continuation of previous work (item no. MIC.04:001) in which it was shown that fully developed laminar flow in a circular tube is stable to small disturbances. In the continuation of the work, two types of disturbances were introduced in the flow at a tube Reynolds number of 4000. The first consisted of an annular ring of 0.0625-in. diameter wire extending from 0.68 to 0.78 radius; the second was an annular 0.0615-in. projection from the wall. Measurements of longitudinal and radial velocity fluctuations and turbulent shearing stresses were obtained with a hot-wire anemometer. Traverses were made at various distances up to 48 diameters downstream of the disturbances. A brief discussion of the investigations is included.

MIC.05:004

Michigan U. Engineering Research Inst., Ann Arbor.

BRILLOUIN ZONE THEORY AND PHOTOGRAPHIC LATENT-IMAGE STUDIES, by G. B. Spence, R. L. Martin and others. Final rept. Mar. 1957, 28p. incl. illus. diags. tables. (Rept. no. 2158-8-F) (AFOSR-TR-57-22) (AF 18(600)750; continued by AF 49(638)69) AD 120475 Unclassified

A theoretical study is made of Brillouin zones, with special regard to the question of the appearance of energy gaps. It has a bearing on the Jones-Hume-Rothery theory of the physical properties of binary substitutional alloys. An investigation is undertaken as part of a plan to check the consequences of theories of the photographic latent-image formation, with a view toward finding the number of atoms necessary to form a developable speck of latent-image silver. This study deals with the dependence of low-intensity reciprocity failure on grain size, other factors being unchanged. Another investigation is undertaken as part of a plan to check the consequences of theories of the photographic latent-image formation, with a view toward finding the number of atoms necessary to form a developable speck of latent-image silver. This investigation is based on the order principle which rests on the hypothesis that for isodense exposures the probability of rendering the last grains developable must be equal. This investigation utilizes isodense data obtained from the sequence exposure experiment. (Contractor's abstract)

MIC.06:005

Michigan U. Engineering Research Inst., Ann Arbor.

THEORY OF HYDROGEN LINE BROADENING IN HIGH-TEMPERATURE PARTIALLY IONIZED GASES, by A. C. Kolb and O. Laporte. Mar. 1957, 155p. incl. illus. diags. tables, refs. (Rept. no. 2189-3-T) (AFOSR-TN-57-8) (AF 18(600)983) AD 115040 Unclassified

An investigation is undertaken to study theoretically the broadening of the hydrogen Balmer lines observed in the radiation of high-temperature partially ionized gases. The theory is based on the classical path approximation for the motion of the perturbers. The general problem of the broadening of a group of lines arising from transitions between "nearly degenerate" states is considered. The method employed is not restricted by the usual assumption of binary collision. The formalism is subsequently specialized to the case where the broadening due to the interactions between an ensemble of ions and a hydrogen atom can be treated as a static perturbation. The validity of this approximation is discussed in detail. The static ion field removes the normal degeneracy of the states of the hydrogen atom. The high-velocity electrons present in the electrically neutral plasma are then shown to cause phase changes and transitions between these nearly degenerate states. The phase shifts due to adiabatic effects and the collision-induced transitions due to nonadiabatic effects are of comparable importance as sources of broadening by electrons. The resultant profile caused by the electron-atom collisions is then averaged over the static ion field splitting with the Holtsmark distribution function. Series expansions for the line profile are obtained which reduce to the Holtsmark expansion for zero electron density and to the dispersion distribution for zero ion density. The principal result of these calculations is that both ions and electrons must be taken into account in the derivation of Balmer line absorption coefficients. (Contractor's abstract)

MIC.06:006

Michigan U. [Engineering Research Inst.] Ann Arbor.

C₂ AND CN EMISSION IN THE SHOCK TUBE, by G. Charatis, L. R. Doherty, and T. D. Wilkerson. [1957] [2]p. incl. illus. (AFOSR-TN-57-505) (AF 18(600)983) Unclassified

Also published in Jour. Chem. Phys. v. 27: 1415-1416, Dec. 1957.

The C₂ and CN band emission produced by shock waves in rare gases is studied to determine the mechanism which produces the luminosity. Experiments in which small amounts of CH₄, C₂H₂ and mixtures of CH₄ and NH₃ were introduced in the expansion chamber gas are

MIC 06:007, 008; MIC 07:002;
MIC 08:002

discussed in terms of the steady atomic and molecular emission which occurs behind reflected shock waves and in terms of the transient C_2 and CN emission which occur at, and immediately behind primary and reflected shock waves. The conclusions are given by means of an outline of the sequence of events following the entry of the molecules in a shock front.

MIC 06:007

Michigan U. [Engineering Research Inst.] Ann Arbor.

LUMINOSITY OF STRONG SHOCK BOUNDARY LAYERS (Abstract), by G. Charatis and T. D. Wilkerson. [1957] [1p. [AF 18(600)983] Unclassified

Presented at meeting of Div. Fluid Dynamics, Amer. Phys. Soc., Lehigh U., Bethlehem, Pa., Nov. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 292, June 19, 1958.

It is possible to make certain features of strong shock flows in the rare gases self-luminous by addition of small amounts of organic vapors to the expansion chamber gas of a shock tube. This technique has been applied to the photographic study of boundary layers in the shock tube. A typical experimental situation is the following: behind a shock wave moving with velocity 2.989 mm/ μ sec through a 99.5% neon — 0.5% CH_4 mixture, the flow

velocity is ~ 2.19 mm/ μ sec, pressure ~ 84.9 cm Hg, temperature $\sim 4340^\circ K$, and therefore the specific

Reynolds number is $\sim 1.15 \times 10^4$ /cm. A vertical slit photograph shows the main stream C_2 band emission

behind the shock to be separated from the wall by a non-luminous laminar boundary layer which grows to a thickness of about 2 mm until transition to turbulence occurs approximately 14 cm behind the shock. The turbulent boundary layer emits the Swan bands of C_2

by virtue of the mixing of cold gas near the wall with hot gas from the main stream. The thickness of the turbulent region appears to grow linearly with distance behind the shock and is 7 mm at the driving interface (42 cm behind the shock).

MIC 06:008

Michigan U. [Engineering Research Inst.] Ann Arbor.

HIGH-TEMPERATURE SHOCK WAVES, by O. Laporte. [1958] [26]p. incl. diagrs. tables, refs. [AF 18(600)983] Unclassified

Published in Combustion and Propulsion, Third Agard Colloquium; Noise, Shock Tubes, Magnetic Effects, Instability and Mixing, Palermo (Italy) (Mar. 17-21, 1958), London, Pergamon Press, 1958, p. 499-524.

The phenomena of modern high-speed aerodynamics with concomitant high temperatures make it necessary for the aerodynamicist to become familiar with such quantum phenomena as molecular vibration, dissociation and ionization. Of the few flow patterns which can be discussed quantitatively, the normal shock has been chosen for detailed presentation because by means of normal shock high temperatures can be produced in the laboratory with relative ease. The methods used are gradually developed in order to make it possible for the investigator to calculate other flows like rare-factions or oblique shocks. The discussion of strong waves is divided into three sections. The first section deals with monatomic gases; whether noble gases or metallic vapors. In the second section an account of shocks in molecular, especially diatomic gases, is given. In the third section, nonequilibrium phenomena and experimental results are reported.

MIC 07:002

Michigan U. Engineering Research Inst., Ann Arbor.

EFFECT OF OZONE UPON FLAME SPEEDS OF SOME COMBUSTIBLE MIXTURES, by R. J. Kelley, R. L. Brehm, and M. E. Gluckstein. Final rept. Mar. 1957, 17p. incl. diagrs. (Rept. no. 2279-10-F) (AFOSR-TR-57-33) (AF 18(600)1186) AD 126510 Unclassified

A study was made of the effect of ozone addition in amounts up to three percent of total mass flow upon the flame speeds of propane, hexane, and carbon monoxide burned with air. It was found that in the combustion of all three fuels the effect of ozone was to increase flame speed. Some specification is made as to the possible mechanism of the observed effects. A qualitative examination was also made of the pre-flame reaction product of ethylene and an air-ozone mixture. Resulting from this, an additional discussion is presented of the possible mechanism that causes decrease in the flame speed of ethylene-air mixtures when ozone is added. The latter phenomenon was observed previously. (Contractor's abstract)

MIC 08:002

Michigan U. Engineering Research Inst., Ann Arbor.

REGENERATIVE HEAT EXCHANGER WITH HEAT-LOSS CONSIDERATION, by E. K. Dabora. Aug. 1957, 19p. incl. diagrs. refs. (Rept. no. 2284-14-T) (AFOSR-TN-57-613) (AF 18(600)1199) AD 136803 Unclassified

The differential equations describing the regenerative type heat exchanger with heat-loss consideration are solved by using Laplace transform. The solution is carried out for two cases: (a) heating the bed from a uniform initial temperature equal to that of the surroundings with fluid at constant inlet fluid temperature, and

MIC.08:003-005; MIC.09:002

(b) cooling the bed from a uniform temperature with fluid at constant inlet temperature equal to that of the surroundings. Typical curves of the transient bed temperature are included for both cases. The steady-state temperature in heating is shown to depend solely on the ratio of the heat loss and fluid heat capacity

$[(s_o U_o / G_p^c) \cdot x]$; therefore, for any heat-exchanger design where the maximum temperature that can be attained at the exit is of importance, this term should be carefully estimated. (Contractor's abstract)

MIC.08:003

Michigan U. Engineering Research Inst., Ann Arbor.

A PRELIMINARY STUDY OF THE APPLICATION OF STEADY-STATE DETONATIVE COMBUSTION TO A REACTION ENGINE, by R. Dunlap, R. L. Brehm, and J. A. Nicholls. Sept. 1957, 16p. incl. diagrs. (Rept. no. 2284-15-T) (AFOSR-TN-57-657) (AF 18(600)1189) AD 136648 Unclassified

Also published in Jet Propulsion, v. 28: 451-456, July 1958.

A reaction type engine employing steady-state detonative combustion is considered. A simplified analysis treats the supersonic mixing of fuel and air together with the requirements necessary to achieve steady-state detonative combustion. Calculations of specific thrust and specific fuel consumption as functions of flight Mach number are made for hydrogen and acetylene fuels. The results of this study indicate that some supersonic diffusion of the air is necessary even though supersonic combustion exists. It is concluded that the speed range of air-breathing engine may be materially extended. (Contractor's abstract)

MIC.08:004

Michigan U. Engineering Research Inst., Ann Arbor.

DESCRIPTION AND EXPERIMENTAL RESULTS OF TWO REGENERATIVE HEAT EXCHANGERS, by E. K. Dabora, M. P. Moyle and others. Feb. 1958, 23p. incl. diagrs. refs. (Rept. no. 2284-18-T) (AFOSR-TN-58-226) (AF 18(600)1199) AD 154128 Unclassified

Two pebble-type regenerative heat exchangers are described, and experimental results obtained with them are presented. The heat exchangers are for the production of high-temperature (2500°R) air and hydrogen. Hot gases produced by the combustion of a propane-air mixture are passed over a bed of refractory pebbles until the downstream end of the bed reaches the temperature required or slightly above it. Then the gas which is to be heated is passed through the heat exchanger. Since the gases are compressed, the heat exchangers must withstand pressures of about 1000 psi.

MIC.08:005

Michigan U. Engineering Research Inst., Ann Arbor.

STUDIES IN CONNECTION WITH STABILIZED GASEOUS DETONATION WAVES, by J. A. Nicholls, E. K. Dabora, and R. L. Gealer. [1958] [7]p. incl. illus. diagrs. (AFOSR-TN-58-886) (AF 18(600)1199) AD 204100 Unclassified

Also published in Seventh Symposium (Internat'l.) on Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, p. 766-772.

The approach used, the experimental technique, and some of the preliminary results obtained in the attempt to achieve a standing detonation wave are presented. In order to stabilize a gaseous detonation wave certain dynamic conditions must be met, of course, which are dictated by the detonation characteristics of the fuel-oxidant combination employed. Mach numbers of detonation differ for various combustible mixtures but all are relatively high (in the hypersonic range). Further, there is a temperature effect (static temperature of the unburned gases) such that the Mach number of detonation varies approximately inversely with the square root of the temperature. The pressure effect is relatively slight although the Mach number can be reduced somewhat for sub-atmospheric pressures. It is evident, then, that the problem requires that a detonatable mixture be accelerated to a high Mach number with high stagnation temperature and pressure. There must then be some mechanism for generating and stabilizing the detonation. In view of the high stagnation temperatures required, mixing of the fuel and oxidant under stagnation conditions is precluded.

MIC.09:002

Michigan U. Engineering Research Inst., Ann Arbor.

EMISSION SPECTRA OF PROPANE-AIR FLAMES IRRADIATED WITH A 1000-CURIE GOLD SOURCE, by A. Weir, Jr., S. W. Churchill and others. [1957] [8]p. incl. diagrs. table. [AF 18(600)1218] Unclassified

Presented at meeting of the Gas and Fuel Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Abstract published in 131st meeting of the Amer. Chem. Soc. Abstract of Papers, 1957, p. 2-J.

Published in Indus. Engineering Chem., v. 49: 1423-1428, Sept. 1957.

This report presents one phase of an experimental investigation of the effect of intense nuclear radiation upon flames. Equipment was designed to obtain the spectral emission at a series of elevations through a

MIC.09:003; MIC.11:002-004

flat flame subjected to nuclear radiation. The intensities of the C_2 , CH, and OH bands were measured quantitatively. The source of radiation for the emission studies was the same 30 grams of irradiated gold wire used in the flame-speed studies. The flame-speed measurements were carried out at source intensities as high as 10,000 curies. The reported data on spectral emission were obtained after the gold had decayed to 1000 curies. Intense irradiation of propane-air mixtures and flames increases the emission due to CH and C_2 but hardly affects the emission due to OH.

MIC.09:003

Michigan U. Engineering Research Inst., Ann Arbor.

RATE OF PROPAGATION OF PROPANE-AIR FLAME IRRADIATED WITH A 10,000-CURIE GOLD SOURCE, by S. W. Churchill, A. Weir, Jr. and others. [1957] [4]p. incl. illus. diagrs. tables, refs. [AF 16(600)1218] Unclassified

Presented at meeting of the Gas and Fuel Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Abstract published in 131st meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 1-J.

Published in Indus. Engineering Chem., v. 48: 1419-1422, Sept. 1957.

Eunsen flames of premixed propane and air were irradiated with an irradiated gold source having an initial strength of about 10,000 curies. Both the flame zero and the propane-air mixture were exposed to the radiation. The rate of propagation of the flame was increased up to 50% by the radiation. The flame speed fell off rapidly to the normal value as the source decayed below 10,000 curies. The effect of radiation appeared to be about the same over a range of propane to air mass ratios from 0.055 to 0.080 and a range of pressures from 4 to 10 in. of mercury absolute. The effect is attributed to beta radiation, since the estimated number of ion pairs produced by beta radiation exceeds the number produced by gamma radiation.

MIC.11:002

Michigan U. Engineering Research Inst., Ann Arbor.

REVERSIBLE PROPERTIES OF POLYCRYSTALLINE FERROMAGNETS. II. EXPERIMENTAL VARIATION OF THE REVERSIBLE SUSCEPTIBILITY AND Q WITH MAGNETIZATION, by D. M. Grimes. May 1957 [29]p. incl. diagrs. tables, refs. (Technical rept. no. 2; rept. no. 2495-2-T) (AFOSR-TN-57-209) (AF 18(603)8) AD 126506 Unclassified

Detailed experimental results on four samples are re-

ported and analyzed in terms of the expected Q variation as well as the expected susceptibility variation described in Part I (Item no. MIC.11:001). It is concluded that two of the samples have susceptibilities arising very predominately from domain rotation, one from wall motion and one from both. It is assumed that no other mechanisms are operative. It is concluded that Frei and Shtrikman's analysis of the remanent position is valid under only the more restricting conditions described herein.

MIC.11:003

Michigan U. Engineering Research Inst., Ann Arbor.

ADDITIONS OF Fe_2O_3 TO $BaTiO_3$ - $SrTiO_3$ FERRO-ELECTRICS, by H. Diamond and V. Chang. Dec. 1957, 10p. incl. diagrs. (Technical rept. no. 3) (AFOSR-TN-57-391) (AF 18(603)8) AD 132466 Unclassified

If small percentages of Fe_2O_3 are added to polycrystalline $BaTiO_3$ and fired at 1400° as a ceramic, the Curie temperature of the ceramic remains constant while the peak permittivity is lowered. However, if the Fe_2O_3 is added to BaO and TiO_2 , the iron goes into the lattice predominately in the titania sites and decreases the Curie temperature as well as the peak permittivity. Additions of Fe_2O_3 to mixed $BaTiO_3$ - $SrTiO_3$ compositions result both in a lowering of the Curie temperature and a depression of the peak permittivity of the single phase system. No changes in lattice dimensions with the additions were observed when the Ba to Sr ratio was held fixed. (Contractor's abstract)

MIC.11:004

Michigan U. Engineering Research Inst., Ann Arbor.

AN INVESTIGATION OF REACTIONS IN FERROSPINELS BY DIFFERENTIAL THERMAL ANALYSIS, by C. F. Jefferson. July 1957, 8p. incl. diagrs. refs. (Technical rept. no. 4; rept. no. 2495-6-T) (AFOSR-TN-57-540) (AF 18(603)8) AD 136526 Unclassified

Differential thermal analysis has been used to follow the oxidation of magnetite in solid solution with a nickel-zinc ferrosipinel, and the solid-state reaction leading to the formation of the ferrosipinel from the oxides. Differential thermal curves for the series $Ni_{.474}Zn_{.526}Fe_2O_4 - Fe_3O_4$ are shown and explained. An attempt was made to follow the solid-state reaction which occurs during the formation of the ferrosipinel from the oxides. (Contractor's abstract)

MIC.11:005-007; MIC.12:002, 003

MIC.11:005

[1958] [7]p. incl. diagrs. tables, refs. (AF 18(603)8)
Unclassified

Michigan U. [Engineering Research Inst.] Ann Arbor.

LOW-TEMPERATURE HEAT CAPACITIES AND THERMODYNAMIC PROPERTIES OF ZINC FERRITES. III. EFFECT OF COPPER SUBSTITUTION, by D. M. Grimes and E. F. Westrum, Jr. Jan. 1959, 17p. incl. diagrs. tables. (Technical rept. no. 6) (AFOSR-TN-58-980) (AF 18(603)8) AD 205877 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 10: 120-125, July 1959.

The heat capacities of annealed and quenched samples of $\text{Cu}_{0.05}\text{Zn}_{0.90}\text{Fe}_{2.05}\text{O}_4$ have been determined over the range 5-350°K. The Néel temperature is the same as previously reported for a similar lithium-substituted zinc ferrite. The result is discussed in terms of sublattice population and molecular field coefficients. (Contractor's abstract)

Presented in part at Conf. on Magnetism and Magnetic Materials, Washington, D. C., Nov. 1957.

Published in Jour. Phys. Chem. Solids, v. 6: 280-286, Aug. 1958.

The heat capacities of annealed and quenched samples of $\text{Li}_{0.005}\text{Zn}_{0.90}\text{Fe}_{2.05}\text{O}_4$ and of quenched ZnFe_2O_4 have been determined over the range 5-350°K. Addition of lithium to zinc ferrite lowers the temperature of the cooperative thermal anomaly associated with antiferromagnetic ordering transition in accord with theory, and quenching of either material results in nearly complete disappearance of the λ -anomaly but modifies the pronounced high-temperature tail less significantly. The effects on the thermal properties are interpreted in terms of sublattice populations. (Contractor's abstract)

MIC.11:006

MIC.12:002

Michigan U. Engineering Research Inst., Ann Arbor.

Michigan U. Engineering Research Inst., Ann Arbor.

EFFECT OF THERMAL HISTORY ON THE ANTIFERROMAGNETIC TRANSITION IN ZINC FERRITE, by D. M. Grimes and E. F. Westrum, Jr. [1958] [2]p. incl. diagr. (AF 18(603)8) Unclassified

INSTABILITY OF THE BOUNDARY LAYER NEAR THE NOSE OF A BLUNT BODY, by A. M. Kuethe. [Oct. 22, 1957] 1p. (In cooperation with the Rand Corp., Santa Monica, Calif.) [AF 18(603)34] Unclassified

Presented at Conf. on Magnetism and Magnetic Materials, Washington, D. C., Nov. 1957.

Published in Jour. Appl. Phys., v. 29: 384-385, Mar. 1958.

Quenched zinc ferrite is ferrimagnetic, annealed ferrite paramagnetic at 300°K. Although annealed zinc ferrite has a lambda-type heat capacity transition at about 9.5°K, quenched zinc ferrite retains only elementary vestigia of this transition. A similar effect exists in $\text{Li}_{0.05}\text{Zn}_{0.90}\text{Fe}_{2.05}\text{O}_4$ in which the transition temperature is slightly lowered relative to that of zinc ferrite. This temperature shift does not appear to exist for $\text{Ni}_{0.1}\text{Zn}_{0.9}\text{Fe}_2\text{O}_4$. The magnetic entropy at 300°K is essentially unaltered by lithium substitution or thermal history. (Contractor's abstract)

Near the nose of a body the positive $\partial\mu/\partial x$ causes stretching of that vorticity component parallel to the streamlines. Therefore if the boundary layer contains three dimensional disturbances the stretching will have a destabilizing effect on the flow. This destabilizing effect is counteracted by the stabilizing effect of the convex curvature near the nose (Taylor-Görtler stability). It is shown by means of an approximate analysis that, since velocities, and therefore centrifugal forces on displaced particles within the boundary layer, are small near the stagnation point the destabilizing effect of stretching will overbalance the stabilizing effect of curvature near the nose of a body. In this region the effect of cooling the body is to further destabilize the boundary layer. It is inferred therefore that under conditions of high heat transfer to the body the instability of the flow may become great enough to cause transition to turbulent boundary layer to occur near the nose. Disturbances with a vorticity component normal to the streamlines (Tollmien-Schlichting waves) will also stretch and thus tend to amplify near the nose of a body because of the diverging streamlines in that region. (Contractor's abstract)

MIC.11:007

MIC.12:003

Michigan U. Engineering Research Inst., Ann Arbor.

Michigan U. [Engineering Research Inst.] Ann Arbor.

LOW-TEMPERATURE HEAT CAPACITIES AND THERMODYNAMIC PROPERTIES OF ZINC FERRITES-II. EFFECT OF THERMAL HISTORY AND METALLIC ADDITIVES, by E. F. Westrum, Jr. and D. M. Grimes.

TRANSITION TO TURBULENT FLOW IN TUBES AND

MIC.12:004, 005; MIC.18:001, 002

IN BOUNDARY LAYERS (Abstract), by A. M. Kuethe.
Oct. 22, 1957 [1]p. [AF 18(803)34] Unclassified

Investigations in tubes and in boundary layers have given some insight into the processes of transition. Measurements in tubes show traverses of the Reynolds stress throughout the transition region. The high stresses developed are interpreted as a cause for the relatively high recovery factor in the transition region. Preliminary measurements in boundary layers show the effect of stability of the layer on the rate of growth of turbulent spots. Other aspects of transition will be discussed.

MIC.12:004

Michigan U. [Engineering Research Inst.] Ann Arbor.

ON THE STABILITY OF FLOW IN THE BOUNDARY LAYER NEAR THE NOSE OF A BLUNT BODY, by A. M. Kuethe. [Jan. 1958] [18]p. incl. illus. diags. (AFOSR-TN-58-21) (AF 18(803)34) AD 148080
Unclassified

Abstract published in Zeitschr. Angew. Math. Mech. (ZAMM) v. 38: 312-313, July/Aug. 1958.

An approximate analysis indicates that the stretching of vortex filaments because of the change in body cross-sectional area and the positive velocity gradient near the nose of a body is a destabilizing influence on the flow in the boundary layer. The analysis predicts that the destabilizing influences of stretching and of surface cooling on the flow over the convex surface exceeds the stabilizing influence of curvature up to a certain distance from the nose. Hot-wire observations near the nose of a body of revolution show regular fluctuations which lie in the range of Reynolds numbers for which the linearized theory predicts stability for Tollmien-Schlichting disturbances. The observations can be rationalized qualitatively in terms of the analysis given here. (Contractor's abstract)

MIC.12:005

Michigan U. [Engineering Research Inst.] Ann Arbor.

ON THE CHARACTER OF THE INSTABILITY OF THE LAMINAR BOUNDARY LAYER NEAR THE NOSE OF A BLUNT BODY, by A. M. Kuethe. [1958] [2]p. incl. illus. diagr. (AF 18(603)34) Unclassified

Published in Jour. Aeronaut. Sciences, v. 25: 338-339, May 1958.

Records were obtained of the hot-wire response to velocity of fluctuations in the boundary layer of a body of revolution with a hemispherical nose 11.5 in. in diameter at wind speeds up to 134 ft/sec in a 5x7 ft low-turbulence tunnel. Bursts of approximately sinusoidal

fluctuations which occurred indicate that the instability is probably of the Tollmien-Schlichting type. It is suggested that one of the sources of instability that has never been mentioned before might be the stretching of the vortex filaments in the region of diverging flow near the stagnation point. Approximate analysis of the destabilizing influences of stretching and surface cooling compared with the stabilizing influence of curvature indicates that near the nose the net effect is destabilizing. Also, when convex curvature is introduced, the centrifugal force acting on a displaced particle causes a destabilizing influence. It is believed that if the curvature is large enough, the effect of cooling a surface may be destabilizing to Tollmien-Schlichting disturbances.

MIC.18:001

Michigan U. Engineering Research Inst., Ann Arbor.

ON ELASTIC PLATES OF VARIABLE THICKNESS, by F. Essenburg and P. M. Naghdi. Oct. 1957, 13p. incl. diags. refs. (Technical note no. 1; rept. no. 2500-1-T) (AFOSR-TN-57-818) (AF 18(803)47) AD 138807
Unclassified

Also published in Proc. Third U. S. Nat'l. Congress of Appl. Mech., Brown U., Providence, R. I. (June 11-14, 1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 313-319.

This paper contains a derivation of suitable stress-strain relations for elastic isotropic plates of variable thickness which include the effects of transverse shear deformation and normal stress, as well as the variation in thickness. The significance of the results is examined in the light of some simple examples, where in particular for torsion of plates whose thickness is such as to give rise to equilateral triangular and elliptic cross-sections, exact agreement is obtained for the stress distribution with the corresponding results of Saint-Venant's theory of torsion. (Contractor's abstract)

MIC.18:002

Michigan U. Engineering Research Inst., Ann Arbor.

ON AXIALLY SYMMETRICAL PLATES OF VARIABLE THICKNESS, by F. Essenburg. July 1958, 6p. incl. diags. (Technical note no. 2; rept. no. 2500-2-T) (AFOSR-TN-58-174) (AF 18(603)47) AD 152205
Unclassified

Also published in Jour. Appl. Mech., v. 25: 625-626, Dec. 1958.

Axially symmetric plates of variable thickness are considered by employing the basic equations of Reissner's theory for uniform plates (Jour. Appl. Mech., v. 12: 69-

MIC. 18:003, 004; MIC. 19:001;
MIC. 20:001

77, 1945 and Jour. Math. and Phys., v. 29: 90-92, 1950) with the thickness treated as a function of the middle plane coordinates.

MIC.18:003

Michigan U. Engineering Research Inst., Ann Arbor.

RESPONSE OF SHALLOW VISCOELASTIC SPHERICAL SHELLS TO TIME-DEPENDENT AXISYMMETRIC LOADS, by P. M. Naghdi and W. C. Orthwein. Nov. 1958 [24]p. incl. refs. (Technical note no. 4; rept. no. 2500-5-T) (AFOSR-TN-58-993) (AF 18(603)47) AD 205905 Unclassified

Also published in Quart. Appl. Math., v. 18: 107-121, July 1960.

The response of shallow viscoelastic spherical shells to arbitrary time-dependent axisymmetric loads is investigated. The medium is assumed homogeneous and isotropic. Emphasis is placed on unlimited shallow spherical shells, but shallow spherical shell segments are also discussed. The solutions employ the differential equations governing the transverse motion of thin shallow elastic shells, and are obtained with the joint use of the Laplace and the Hankel transforms. The order of the inversions is interchanged, avoiding an otherwise intricate task of contour integration in the complex Laplace transform-plane. Explicit results in integral form are deduced for viscoelastic shells under instantaneous pulse loading, and are particularized to the cases of Maxwell and Kelvin solids. The solutions for a shallow elastic shell and for the case of a flat plate are also given as by-products of the general solution and comparison is made with known results.

MIC.18:004

Michigan U. [Engineering Research Inst.] Ann Arbor.

ON THERMO-ELASTIC STRESS-STRAIN RELATIONS FOR THIN ISOTROPIC SHELLS, by P. M. Naghdi. [Nov. 1958] 5p. [Technical note no. 3; rept. no. 2500-4-T] (AFOSR-TN-58-994) (AF 18(603)47) AD 205904 Unclassified

Also published in Jour. Aero/Space Sciences, v. 26: 125, Feb. 1959.

It is the purpose of the present note to extend previous results of the author (Quart. Appl. Math., v. 14: 369-380, Jan. 1957) and to modify the stress-strain relations so as to include the thermal effects in a manner consistent with the assumptions made in the aforementioned work. The defect in the usual formulation of problems of thermoelastic shells that an initially stress-free isotropic shell remain stress-free in a uniform temperature field can be avoided by assuming a particular form for the displacement.

MIC.19:001

Michigan U. Engineering Research Inst., Ann Arbor.

CALCULATION OF THE REFLECTION OF RADIATION FROM SAW-TOOTH SURFACES AND THE REFLECTION AND TRANSMISSION OF RADIATION BY PARALLEL CYLINDER SYSTEMS, by W. C. Meecham, S. T. Choh, and D. W. Moomaw. Final rept. Jan. 1958, 36p. incl. diagrs. table, refs. (Rept. no. 2607-5-F) (AFOSR-TR-58-44) (AF 49(638)26) AD 154160 Unclassified

The report is divided into two main parts, comprising Sections II and III. The first part is concerned with the calculation of the reflection of radiation from saw-tooth surfaces. The calculations performed for this problem are based on a variational method. A review of this method is presented. The results of the calculations are given. The computations are restricted to the class of reflection problems where the propagation vector of the incident plane wave is normal to the corrugations of the reflecting surface and where the incident electromagnetic wave is polarized with the electric vector parallel to the corrugations. For an acoustic wave this is equivalent to a pressure release surface. In Section III the problem considered is that of the reflection and transmission of radiation by an infinite system of parallel, circular, equally-spaced cylinders whose axes lie in a plane. Computations are restricted to the case where the propagation vector of the incident plane wave is perpendicular to the axes of the cylinders, and further, to the case where the wave is normally incident on the plane formed by those axes. The theory of Ignatowsky is used in making calculations. The results reported here are all for the case where the radiation wavelength, λ , is greater than the spacing of the cylinders, D . Hence there are no propagating diffracted orders; in this case the sum of the directly transmitted and reflected intensities must be equal to the incident intensity.

MIC.20:001

Michigan U. Engineering Research Inst., Ann Arbor.

AN INVESTIGATION OF THE EFFECTS OF ULTRASONIC ENERGY ON COMBUSTION, by J. A. Boit, D. H. Holkeboer, and W. Mirsky. Final rept. June 1958, 14p. incl. illus. diagrs. (Rept. no. 2634-4-F) (AFOSR-TR-58-75) (AF 49(638)180) AD 158329 Unclassified

This report covers an investigation of the effect of high-intensity sound fields, in the frequency range of 20 to 50 kc, on combustion of natural gas and kerosene. It follows a previous investigation by Mirsky which showed that the presence of ultrasonic energy increases the evaporation rate of fuel drops. Three transducers were developed, two of which were applied to combustion processes. It was noted that ultrasonic energy decreased smoke and carbon formation, apparently increased the burning rate, and increased the tendency for flames to be quenched or extinguished. (Contractor's abstract)

MIC.21:001 - MIC.21:005

MIC.21:001

Michigan U. [Willow Run Labs.] Ann Arbor.

MASER ACTION IN RUBY, by G. Makhov, C. Kikuchi and others. June 1958, 5p. incl. illus. (Rept. no. 2818-1-T) (AFOSR-TN-58-288) (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under AF 49(638)68) AD 154192; PB 135368

Unclassified

Also published in Phys. Rev., v. 109: 1399-1400, Feb. 15, 1958.

An attempt was made to find paramagnetic materials suitable for maser applications. The electron-spin resonance properties of ruby ($\text{Al}_2\text{O}_3:\text{Cr}$) were investigated. Evidence of oscillations and amplification was obtained. Ruby crystals have been used in microwave cavities to test their use as microwave amplifiers. Preliminary measurements have confirmed MASER action involving a $-3/2 - 1/2$ and $-1/2 - 3/2$ transitions. It has been found that the pulse-height and the repetition rate decrease with decreased pumping power. At 4.2°K and $H = 4230$ gauss, the minimum pulse interval was found to be 0.3 msec and the radiated frequency was 9.22 kmc/sec for a pumping frequency of 24.2 kmc/sec. A net gain of 20 db has been observed. Subsequent measurements are intended (see item no. MIC.21:003)

MIC.21:002

Michigan U. Willow Run Labs., Ann Arbor.

LUMINESCENCE OF COLOR CENTERS IN KCl, by J. Baker and J. Lambe. Jan. 1959, 13p. incl. diagrs. tables, refs. (Rept. no. 2616-5-T) (AFOSR-TN-58-914) [AF 49(638)68] AD 204566

Unclassified

Absorption excitation and emission studies were made of the color centers in KCl crystals which were irradiated at 77° and 300°K. A number of absorption bands were observed and tabulated with the basic color centers. The test procedures consisted in warming the crystal to 300°K, decreasing to 77°K to study the absorption and emission properties, and then returning to 300°K to bleach with F-center (0.55μ) light; this cycle was repeated until no further significant changes were made. The bright pink color of the crystal at 77°K gradually deepened, becoming a light purple. Observing the emission at successive stages of bleaching showed that the intensity of the F center decreased, and a small, but noticeable, M center appeared. Crystals that were irradiated at 300°K showed the purple appearance observed in the warmed crystals. The spectra of the 300°K irradiated crystals indicated a large F center absorption with noticeably large R_1 , R_2 , and M center absorption. Although the F center absorption was intense, the emission produced by excitation of the F center was weak.

MIC.21:003

Michigan U. Willow Run Labs., Ann Arbor.

RUBY AS A MASER MATERIAL, by C. Kikuchi, J. Lambe and others. May 1959, 21p. incl. illus. diagrs. refs. (Rept. no. 2616-6-R) (AFOSR-TN-58-938) (AF 49(638)88) AD 216448

Unclassified

Presented at Electron Tube Research Conf., Laval U., Quebec (Canada), June 26-27, 1958.

Also published in Jour. Appl. Phys., v. 30: 1061-1087, July 1959.

A general study of its properties has shown that ruby possesses numerous advantages as a maser material. Since the energy-level scheme of the ruby system is reasonably simple, four levels can be used, thus making possible push-pull pumping, which substantially increases pumping efficiency. It was found that ruby has suitable spin-lattice relaxation times for good maser operation, and, in addition, that ruby has excellent thermal, electrical, and mechanical properties for its use as maser material. Other materials for which maser action should be investigated have been cited. (Contractor's abstract, modified)

MIC.21:004

Michigan U. Willow Run Labs. [Ann Arbor].

SPIN RESONANCE OF DONORS IN CdS, by J. Lambe and C. Kikuchi. [1958] [3]p. incl. diagr. [AF 49(638)-88]

Unclassified

Presented at Internat'l. Conf. on Semiconductors, Rochester, N. Y., Aug. 18-22, 1958.

Published in Jour. Phys. Chem. Solids, v. 8: 492-494, Jan. 1958.

Experimental results are presented for the paramagnetic spin resonance in a Cl substituted CdS semiconductor. The splitting of the g factor for parallel and perpendicular orientations of the needlelike hexagonal crystal is found to be 0.2 and indicates a donor level closely spaced below the conduction band, with $\Delta E = 2\text{ev}$. No hyperfine structure has been observed.

MIC.21:005

Michigan U. [Willow Run Labs.] Ann Arbor.

DOUBLETS IN THE ELECTRON SPIN RESONANCE SPECTRUM OF Mn^{++} IN CALCITE (Abstract), by C. Kikuchi, R. Ager, and L. M. Matarrese. [1958] 1p. [AF 49(638)68]

Unclassified

MIC.21:006; MID.01:001, 002;
MIL.01:001

Presented at meeting of the Amer. Phys. Soc.,
Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
135, Mar. 27, 1958.

Hurd, Sachs, and Hershberger observed that some of the ESR absorption lines of Mn^{++} in a single crystal of calcite were split into doublets for certain orientations of the magnetic field with respect to the optic axis. The spectrum has been reexamined in order to check the suggestion that this splitting is due to the nonequivalent trigonal fields at the two Ca^{++} sites occupied by Mn^{++} and has the dependence $\sin^3 \theta \cos \theta \times 3\psi$, where θ is the angle between H and the optic axis. For a given θ the doublet separation is zero or a maximum when the direction of H is varied in a plane parallel ($\cos 3\psi = 0$) or normal ($\cos 3\psi = 1$) to a symmetry plane passing through the optic axis, respectively. In the latter case the maximum splitting occurs at $\theta = 60^\circ$ and is about 18 gauss, in good agreement with theory. In addition to the above-mentioned doublets, the spectrum contains five pairs of weak lines occurring midway between the principal hfs lines. The mechanism responsible for these lines will be discussed.

MIC.21:006

Michigan U. [Willow Run Labs.] Ann Arbor.

EFFECT OF BLEACHING ON F-CENTER PARAMAGNETIC RESONANCE (Abstract), by J. Lambe and J. Baker. [1958] 1p. [AF 49(638)68] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3:
136, Mar. 27, 1958.

An experimental study has been carried out on the relationship between F-band optical density and paramagnetic resonance absorption as the number of F centers is reduced by bleaching. Crystals of KCl were colored by Co^{60} gamma irradiation. Measurements were then made of the above quantities. F-band optical density was measured at 5460A and F-center paramagnetic absorption was measured using an X-band magnetic resonance spectrometer. The crystals were then bleached for varying periods of time with light of wavelength 5800A and the measurements were repeated after each bleaching. It was found that the paramagnetic absorption decreased more rapidly than the optical density. This is not in agreement with what should be expected on a simple picture of the F-band optical absorption. It indicates that either some other mechanism is operative in producing optical absorption in the F-band region, in addition to the normal F-center absorption, or that the optical properties of the F center are affected by the changes which bleaching induces.

MID.01:001

Midwest Research Inst., Kansas City, Mo.

THE PADÉ TABLE AND THE τ -METHOD, by Y. L. Luke. Aug. 1957, 42p. incl. tables, refs. (AFOSR-TN-57-570) (AF 49(638)66) AD 136555 Unclassified

Also published in Jour. Math. Phys., v. 37: 110-127, July 1958.

Rational function representations of the function E are presented as defined by a differential equation of a standard form. Closed form expressions for the error are derived and used to appraise the error in a convenient manner. Rational approximations to the transcendents defined by the differential equation are derived by the τ method. Numerical examples are worked out and the true error is compared with that predicted.

MID.01:002

Midwest Research Inst., Kansas City, Mo.

A GENERALIZATION OF A THEOREM OF LAGUERRE, by Y. L. Luke. June 15, 1958, 27p. (AFOSR-TN-58-48) (AF 49(638)66) AD 158295 Unclassified

Additional results are given concerning the function $E(z) = {}_2F_1(a, b; c; -1/z)$ and a rational approximation to it, $E_n(z) = \phi_n(z)/f_n(z)$. The differential equation satisfied by $f_n(z)$ is constructed and matched with a known differential equation for $f_n(z)$. This analysis leads to a system of 2 linear differential equations involving $f_n(z)$ and 2 other polynomials, θ_n and H_n . A proof is given that if $\alpha = 0$ (α appears in the definition of $\phi_n(z)$ in the τ -procedure), θ_n and H_n are independent of $f_n(z)$. This fact is used to prove that $f_n(z)$ and g_n satisfy the same differential equation where $g_n = (\phi_n - Ef_n)z^{-\alpha}(z+1)^{\alpha-\lambda}$. Various representations of $\phi_n - Ef_n$ are constructed.

MIL.01:001

Milan U. Inst. of General Pathology (Italy).

COENZYME A CONTENT IN LIVERS AFFECTED BY VARIOUS DEGENERATIVE CHANGES, by C. Severi-Fonnesu, A. Fonnesu, and C. Agostini. [1958] [11]p. incl. tables, refs. (AF 61(514)1026) AD 226153 Unclassified

Also published in Italian Jour. Biochem., v. 7: 215-225, July-Aug. 1958.

Coenzyme A (CoA) has been estimated in livers affected

MIL.02:001, 002; MIL.03:001

by various degenerative changes: cloudy swelling, cell vacuolation and fatty change (CCl_4 and phosphorus).

Livers from animals treated with a single injection of CCl_4 or phosphorus have also been examined for CoA.

With the aim of detecting not only the real changes of intact CoA but also the possible accumulation of CoA precursors, CoA has been determined on each tissue sample by two different methods. With the first method CoA precursors are partially estimated as CoA; the second method is specific for intact CoA. In no case differences have been detected between CoA values obtained by the first method and those obtained by the second method. This indicates that the amount of CoA precursors is very small in both normal and pathological livers. CoA content is unchanged in livers affected by cloudy swelling and cell vacuolation, as compared with normal controls. In fatty livers produced with either CCl_4 or phosphorus, CoA content is markedly decreased.

A marked decrease of liver CoA also occurs after a single injection of phosphorus. The results are briefly discussed. (Contractor's abstract)

MIL.02:001

[Milan U. Lab. of Physiology (Italy)].

EFFECT OF STRESS IN LOWER NEURON ACTIVITY, by R. Margaria, T. Gualtierotti, and D. Spinelli. [1958] 11p. incl. illus. diagr. tables, refs. (AFOSR-TN-58-537) (AF 61(514)637) AD 158353

Unclassified

Presented at the Internat'l. Symposium on Military Psychology, Brussels (Belgium), July 26, 1957.

Published in Exper. Med. and Surg., v. 16: 166-176, June-Sept. 1958.

Monosynaptic reflexes have been produced in the sciatic territory by means of direct stimulation of this mixed nerve: in this way two responses are collected as action currents from the muscle, the first being due to the stimulation of the motor fibers, the second, delayed, due to stimulation of the sensory fibers, the responses of the muscle in the last event being due to a reflex mechanism. If such a stimulation is repeated at two points well apart along the course of the nerve at a known distance, an exact indication can be obtained of the conduction speed of both motor and sensory fibers and the central delay is then easily calculated together with the end-plate delay. The very short pulse, 75 msec, used for stimulation minimizes the error due to the variability of the position of the active point in the stimulus duration. Another element which has been studied is the so-called Renshaw phenomenon, namely the suppression of a second reflex response following the first at an interval of less than 200-250 msec. This phenomenon is very easily affected by any upsetting condition. The following single components and characteristics of the monosynaptic reflex in man have been studied during

stress: (1) total reflex time; (2) spinal delay; (3) end-plate delay; (4) motor conduction speed; (5) sensory conduction speed; and (6) Renshaw suppression phenomenon. The results are given for the following conditions of stress: (a) hypoxia; (b) hypoglycaemia; (c) muscular fatigue due to prolonged physical effort; (d) action of drugs: caffeine, barbiturates, alcohol; and (e) lack of sleep.

MIL.02:002

Milan U. Lab. of Physiology (Italy).

INVESTIGATION OF THE FATIGUE IN MAN. Final rept. [1957] 7p. (AFOSR-TN-58-117) (AF 61(514)637; continued by AF 61(52)23) AD 202359 Unclassified

Some fundamental characteristics of lower neuron activity as a means of investigating fatigue in man, has been studied. Such research was based on the assumption that even if fatigue is a very unprecise and general term covering a number of stress-inducing conditions, a common factor should exist consisting of some widespread change in the central nervous system. In fact, internal or external stresses are bound to cause the earliest possible response in the organism from the central nervous system. It was also assumed that any change in the central nervous system might lead to a variation in lower neuron activity, in the terminal centers of the efferent pathways of the CNS, namely the neurons of the spinal cord, both internuncial and motor.

MIL.03:001

Milan U. Lab. of Physiology (Italy).

EFFECT OF ACCELERATIONS ON CEREBELLAR POTENTIALS IN BIRDS AND ITS RELATION TO THE SENSE OF DIRECTION, by B. Schreiber, T. Gualtierotti, and D. Mainardi. [1957] 10p. incl. diagrs. (AFOSR-TN-57-519) (AF 61(514)968) AD 136601

Unclassified

Also published in Amer. Jour. Physiol., v. 197: 469-474, Aug. 1959.

Rotary and post-rotary cerebellar responses of homing and domestic pigeons, and of migratory and sedentary doves have been studied by means of an orientable centrifuge. Little difference was found in rotary responses among all the animals tested. Spindle-like post-rotary discharges were recorded in the majority of migratory birds while only 6-8% of the domestic pigeons and no sedentary doves showed similar after-charges. The results seem to support Ising's theory regarding the Coriolis force as a base for direction sense in animals.

MIL. 03:002, 003; MIL. 04:001;
MIH. 01:001

MIL.03:002

Milan U. [Lab. of Physiology] (Italy).

[CEREBELLAR ACTIVITY AND NUCHAL ELECTROMYOGRAM IN THE HOMING PIGEON] Attivita' cerebellare ed elettromiogramma nucale nel piccione viaggiatore, by B. Schreiber, T. Gualtierotti, and D. Malnardi. [1957] [4]p. incl. illus. (Sponsored jointly by Air Force Office of Scientific Research under AF 61-514)968 and Rockefeller Foundation) Unclassified

Published in Rend. Ist. Lomb. Sci. e Lett., v. 92: 187-190, 1957.

Experiments designed to record jointly the electrical activity of the cerebellum and the neck muscles permit it to be concluded that the activities recorded in the centrifugal stimulation of pigeons, which discriminate between homing and non-homing races, are not an artifact due to diffusion of potentials from the neck muscles but an expression of cerebellar activity. (Contractor's abstract)

MIL.03:003

Milan U. Lab. of Physiology (Italy).

PROLONGED AFTER-EFFECT OF CENTRIPETAL AND TANGENTIAL ACCELERATIONS ON CEREBELLAR POTENTIALS. Final rept. June 1, 1956-Sept. 30, 1957, 5p. (AFOSR-TR-58-37) (AF 61(514)968) AD 152246 Unclassified

The rotatory and post-rotatory responses of domestic and nonmigratory species were compared with the responses of homing pigeons and migratory birds. Results indicated that the cerebellar cortex of birds is highly sensitive to rotatory acceleration. A response was obtained at a value as low as 0.01 to 0.02 g. The stimulation of the cerebellar neurons resulted from changes of the sensory inflow coming from the labyrinth. Bilateral labyrinthectomy completely abolished the cerebellar response. A highly typical, spindle-like afterdischarge was found only in homing pigeons and migratory birds.

MIL.04:001

Milan U. Lab. of Physiology (Italy).

WIDE RANGE ACCELERATION INVESTIGATIONS IN MAN AND ANIMALS, by R. Margaria. [1958] 26p. (AFOSR-TN-58-516) (AF 61(514)968 and AF 61(052)23; continuation of AF 61(514)537) AD 158327 Unclassified

Presented at Twenty ninth annual meeting of the Aero Med. Assoc., Washington, D. C., Mar. 24, 1958.

Also published in Jour. Aviation Med., v. 29: 855-871, Dec. 1958.

On the basis of elementary laws of physics, describing the behavior of bodies floating in a fluid and subjected to acceleration, consideration has been given to possible protection against acceleration forces. Immersion of mammals (mice) in water increases the resistance to acceleration more than ten fold. Impacts of more than 1000 G have been sustained by such animals as opposed to 100 G when not immersed. Animals without air cavities in the body, such as fish or mammalian fetuses, can support higher acceleration forces. The threshold of physiological stimulation of the otolithic apparatus in all directions has been determined in man floating in water. Lack of impulses from this apparatus is possibly of no serious consequences on the functionality of the brain. The threshold for gravity stimulation of the labyrinth in mammals as from the induced changes of the electrical activity of the flocculo-nodular lobe of cerebellum is of the order of 0.01 to 0.005 G. The loss of orientation, as an effect of radar on homing pigeons, is considered as a possible temperature effect. Migratory animals respond to acceleration stimulus with peculiar spindle-like bursts of cerebellar action potentials lasting some time after removal of the stimulus. This peculiarity is in accord with the hypothesis that migration in animals is possibly supported by a higher sensitivity to geodetic forces. The possible geodetic forces that may induce migration are considered, particularly the accessory Coriolis acceleration; they are of the order of magnitude of 1×10^{-6} G, which is much lower than the threshold to stimulation as found experimentally on the same animals. The physiological basis to account for animal migration is still lacking. (Contractor's abstract)

MIH.01:001

[Minneapolis-Honeywell Regulator Co., Hopkins, Minn.].

SURFACE PROPERTIES OF CLEAVED GERMANIUM SURFACES IN ULTRA-HIGH VACUUM (Abstract), by D. R. Palmer and C. E. Dauenbaugh. [1956] [1]p. [AF 49(638)597] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 138, Mar. 27, 1958.

A method of obtaining "clean" germanium surfaces by cleaving germanium in ultra-high vacuum (2×10^{-9} mm Hg) has been devised. The experiment arrangement, which allows measurement of the conductance, field effect (effective mobility and slow relaxation), and photoconductivity, will be explained. A preliminary experiment on a p-type sample shows that the surface is p type

MIN.02:003 - MIN.02:007

upon cleavage. The effective mobility variation, upon an increase in pressure, is of the type observed in the experiments on argon bombarded surfaces.

MIN.02:003

Minnesota U., Minneapolis.

AN OPERATOR IDENTITY, by G. Baxter. Aug. 1, 1957 [24]p. (Technical rept. no. 3) (AFOSR-TN-57-424) (AF 18(603)30) AD 136413 Unclassified

Also published in Pacific Jour. Math., v. 8: 649-663, 1958.

Let M be a matrix, let M^+ be formed by setting equal to zero all elements of M on or below the diagonal, and let $M^- = M - M^+$. Equations $P = I + s(MP)^+$ and $G = I + s(QM)^-$ are investigated and their solutions applied to certain problems in the theory of probability where M is the transition probability matrix of a Markov chain. Extension to certain operators M is carried through. (Contractor's abstract)

MIN.02:004

Minnesota U., Minneapolis.

INVERSION FORMULAE FOR CHARACTERISTIC FUNCTIONALS OF STOCHASTIC PROCESSES, by R. H. Cameron and M. D. Donsker. Sept. 1957 [20]p. (AFOSR-TN-57-603) (AF 18(603)30) AD 136592 Unclassified

Also published in Ann. Math., v. 69: 15-36, Jan. 1959.

Let $\{x_t, t \in [0,1]\}$ be a stochastic process in which almost all of the functions $x(t, \cdot)$ equal zero for $t = 0$ and satisfies the condition of Hölder with $\alpha > \frac{1}{2}$ and let $\{p_t\}$ be the Wiener process. The characteristic functional of x_t is defined, in the more general conditions, by the

formula $\Phi(p) = E \left[\exp i \int_0^1 x(t) dp(t) \right]$. The following

formula: $E_x [G[x]] = \lim_{\lambda \rightarrow 0} 2^{-\frac{1}{2}} \exp (\lambda f(\lambda)/2)$

$x E_a^W E_p^W \exp \{-i \lambda f(\lambda) \int_0^1 a(t) dp(t) G[f(\lambda) a] \Phi(\lambda p)\}$

is proven for every G functional, defined and limited for the space of functions continued according to $[0,1]$ and zero for $t = 0$, continued according to the uniform topology and measurable Wiener and for $0 < f(\lambda) = O(\lambda/\log \lambda)^2$, $1/f(\lambda) = O(\lambda^{1-1/\alpha})$. An analogous formula is proven for the "strictly, absolutely, continuous" process and another formula is proven for the G functionals continued according to the Hilbert topology.

MIN.02:005

Minnesota U., Minneapolis.

ON THE MEASURE OF HILBERT NEIGHBORHOODS FOR PROCESSES WITH STATIONARY, INDEPENDENT INCREMENTS, by G. Baxter. Jan. 1, 1958, 7p. (Technical note no. 6) (AFOSR-TN-58-159) (AF 18(603)30) AD 152185; PB 138862 Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 690-695, Oct. 1959.

The double Laplace transform of the measure of the Hilbert neighborhood of the origin for processes with stationary, independent increments is shown to be the solution of a certain differential equation. The proof is based on work by Kac. Examples are given, including an evaluation for the measure of the Hilbert neighborhood of the origin for the Poisson process. (Contractor's abstract)

MIN.02:006

Minnesota U., Minneapolis.

ON A SPECIAL INTEGRAL EQUATION, A LINEAR PARABOLIC DIFFERENTIAL SYSTEM, AND A WIENER INTEGRAL, by D. A. Woodward. Jan. 1958 [4]p. (Technical note no. 5) (AFOSR-TN-58-567) (AF 18(603)30) AD 158386 Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 853-854, Dec. 1959.

Three questions, which are shown to be equivalent by a paper by Cameron, are answered in the negative by answering the first question in the negative. The first question asks whether $y(t) = x(t) + \int_0^t [x(s)]^2 ds$, $0 \leq t \leq 1$ has a solution $x \in C$ for almost every choice of $y \in C$. C denotes the space of continuous functions on $0 \leq t \leq 1$ which vanish at $t = 0$, and "almost every" means all but a set of Wiener measure zero.

MIN.02:007

Minnesota U., Minneapolis.

ON THE REGULARITY OF GAUSSIAN PROCESS SAMPLE FUNCTIONS, by M. D. Donsker. Jan. 1, 1958, 11p. (Technical note no. 7) (AFOSR-TN-58-1060) (AF 18(603)30) AD 261919 Unclassified

Let $\{x_t, 0 \leq t \leq 1\}$ be a Gaussian process with mean function zero and covariance function $\rho(s,t)$ continuous in both its variables. In this note certain connections between the regularity of the sample-functions x_t and the asymptotic properties of related Fredholm determinants are discussed.

MIN.03:002; MIN.05:002, 003
MIN.14:001

MIN.03:002

Minnesota U., Minneapolis

DIMENSIONAL EFFECT ON THE INITIAL PERMEABILITY AND PERMITTIVITY MEASUREMENTS, by D. Chen, W. E. Swanson, and S. P. Yu. [1957] [7]p. incl. diagrs. (AFOSR-TN-57-18) (AF 18(803)113) AD 115048 Unclassified

A dimensional effect has been observed in the initial permeability measurement of micron-sized $\gamma\text{-Fe}_2\text{O}_3$ particles and paraffin mixtures using the "transmission line method" at 9000 mc. The peaking of the phase angle of the characteristic impedance at sample lengths equal to a multiple of a quarter wavelength apparently cannot be accounted for by higher order modes or a cavity resonance. Calculation reveals that the phase angle is sensitive to the non-ideal terminations of the transmission line and the error in the location of the voltage minimum at these lengths. For optimum accuracy in the permeability and permittivity measurements the sample length should be one-eighth of the wavelength in the material.

MIN.05:002

Minnesota U. Dept. of Aeronautical Engineering, Minneapolis.

AIRFOIL IN A SONIC SHEAR FLOW JET. A MIXED BOUNDARY VALUE PROBLEM FOR THE GENERALIZED TRICOMI EQUATION, by C.-C. Chang and T. S. Lundgren. May 1958 [32]p. incl. diagrs. refs. (Rept. no. 1) (AFOSR-TN-58-521) (AF 18(600)1456) AD 158334; PB 140458 Unclassified

Also published in Quart. Appl. Math., v. 17: 375-392, Jan. 1960.

Small perturbations of a non-uniform two-dimensional flow of a compressible inviscid fluid are considered. It is shown that for a particular class of main stream Mach number of distributions, which are characterized by a sonic line along x-axis, the linearized shear flow equation may be transformed into the generalized Tricomi equation. The mixed boundary value problem which results from considering perturbations generated by a two-dimensional camber surface is formulated and solved by utilizing the Wiener-Hopf technique. (Contractor's abstract)

MIN.05:003

Minnesota U. Dept. of Aeronautical Engineering, Minneapolis.

EFFECT OF SLIGHT MODIFICATIONS OF BOUNDARY ON POTENTIAL TRANSONIC CHANNEL FLOW, by C.-C. Chang and C.-W. Chu. June 1958 [20]p. incl.

diagrs. refs. (Rept. no. 2) (AFOSR-TN-58-528) (AF 18(600)1456) AD 158339 Unclassified

This is an extension of the paper by Chang and Chu in which a symmetrical neighboring solution of Temple-Yarwood transonic channel flow along a slightly less convex but still analytic inner boundary was obtained numerically with the relaxation method. Two types of symmetrical inner channel boundary are considered: namely, a slightly less convex contour and a slightly more convex contour than that of the original Temple-Yarwood flow. First, an unsymmetrical flow solution of the case of the slightly less convex contour is obtained. Secondly, the case of a slightly more convex analytic contour is investigated. Both the symmetrical and the unsymmetrical flow solutions are also obtained with the relaxation method. Physical reasoning indicates that the unsymmetrical potential flow solutions are more likely to occur. It is found that within the chosen accuracy, potential transonic neighboring solutions exist for both the more convex and the less convex boundaries. For the unsymmetrical flow solution with the more convex boundary, the characteristics starting from five neighboring points near the crown of the inner channel boundary are calculated and plotted. There appears no tendency of focusing of these characteristics as they propagate downstream, reflected by the sonic line and the inner channel wall. No shock is discovered. (Contractor's abstract)

MIN.14:001

Minnesota U. Dept. of Aeronautical Engineering, Minneapolis.

ELASTIC INSTABILITY OF RECTANGULAR SANDWICH PANEL OF ORTHOTROPIC CORE WITH DIFFERENT FACE THICKNESSES AND MATERIALS, by C.-C. Chang and I. K. Ebcioğlu. Mar. 1958 [54]p. incl. diagrs. tables, refs. (Composite Structure rept. no. 1) (AFOSR-TN-58-221) (AF 18(603)112) AD 154122; PB 134752 Unclassified

Also published in Jour. Appl. Mech., v. 27: 474-480, Sept. 1960.

This paper treats the elastic instability of rectangular sandwich panels of orthotropic core and faces with different materials and unequal thicknesses. The panel is simply supported and loaded with edge compression. The differential equations and corresponding boundary conditions are derived from the classical energy integral by means of the variational method. The critical edge compression per unit width can be expressed as a product of two parts: the major buckling coefficient and critical buckling load. The complicated geometrical parameters and different component materials are included in a single graph. The effect of different face temperatures on the maximum collapsing load can be interpreted from the present theory. A comparison with current different methods is given. A number of illustrating examples are shown. (Contractor's abstract)

MIN. 14:002; MIN. 15:001; MIN. 16:001, 002;
MIN. 07:010

MIN. 14:002

Minnesota U. [Dept. of Aeronautical Engineering]
Minneapolis.

ELASTIC THEORY OF A WEAK-CORE SANDWICH
PANEL, INITIALLY WARPED, SIMPLY SUPPORTED
AND SUBJECTED TO COMBINED LOADINGS, by C.-C.
Chang, B. T. Fang, and I. K. Ebcioğlu. [1958] [8]p.
incl. diagre. (AFOSR-TN-58-525) (AF 18(603)112)
AD 158338 Unclassified

Also published in Proc. Third U. S. Nat'l. Congress of
Appl. Mech., Brown U., Providence, R. I. (June 11-14,
1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 273-
280.

Based on small deflection theory, differential equations
for the elastic bending and deflection of an orthotropic
weak-core sandwich panel with small initial warping
are derived by the variational energy method. The loads
applied consist of arbitrarily distributed transverse
loads and eccentrically applied edge loads and/or edge
moments. Solutions of the differential equations for a
simply supported rectangular panel with arbitrary initial
warping and subjected to combined transverse loading
and edge compression are obtained in the form of
double Fourier series. (Contractor's abstract)

MIN. 15:001

Minnesota U. Dept. of Electrical Engineering,
Minneapolis.

TENTATIVE RESEARCH PROGRAM ON GASEOUS
ELECTRONICS (Abstract), by H. J. Oskam. [1958] [2]p.
(Bound with its AFOSR-TR-58-125; AD 162274) (AF 49-
(638)378) Unclassified

Presented at Conf. on Ion and Plasma Research,
Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The following research is planned in this report: (1)
Microwave studies of afterglow phenomena (including
the study of afterglow properties in pure gases, in mix-
tures of rare gases, and mixtures of rare gases and
hydrogen; (2) Study of the possibility of combining mass-
spectroscopical studies of the afterglow with the micro-
wave method; and (3) Spectroscopical studies of gas
mixtures.

MIN. 16:001

Minnesota U. [Dept. of Mathematics] Minneapolis.

TENSOR PRODUCTS OF BANACH ALGEBRAS, by
B. R. Gelbaum. Apr. 30, 1958 [20]p. (AFOSR-TN-58-
373) (AF 49(638)64) AD 154279 Unclassified

Also published in Canad. Jour. Math., v. 11: 297-310, 1959.

Let A and B be communicative Banach algebras, and let
C be their tensor product, $A \otimes B$, with the "greatest
cross norm". If A and B have units, then the space
 $\Delta(C)$ of complex homomorphisms of C is in a natural way
the product $\Delta(A) \times \Delta(B)$. In the present paper, the corre-
sponding proposition for algebras without units is proved.
(Math. Rev. abstract)

MIN. 16:002

Minnesota U. [Dept. of Mathematics] Minneapolis.

ON ISOMETRIC EQUIVALENCE AND SIMILARITY OF
CERTAIN VOLTERRA OPERATORS, by G. K. Falisch.
June 12, 1958, 15p. (AFOSR-TN-58-535) (AF 49(638)-
64) AD 158351; PB 135412 Unclassified

Also published in Proc. Amer. Math. Soc., v. 12: 93-98,
Feb. 1961.

The functions considered are of the general form:

$F(x,y) = (y-x)^{m-1} aG(x,y)$, where m is a positive inte-
ger, $|a| = 1$, $G(x,y) > 0$, and the complex valued function
 $G(x,y)$ is continuously differentiable. Proof is presented
of the theorem: Let c_1 and c_2 be complex numbers and

let r_1 and r_2 be real numbers such that $r_1 \geq 1$, then

$c_1 T_{E1}^{r_1}$ is similar to $c_2 T_{E2}^{r_2}$ if and only if $c_1 = c_2$ and
 $r_1 = r_2$. The class D of the functions F are described

as the functions F are of the general form where G and
m satisfy one of the following: (1) G is analytic in a suit-
able region and m is arbitrary; (2) $G(x,y) = G(y-x)$,
 $G(0) \neq 0$, $G \in C^2$, and m is arbitrary; (3) $G \in C^2$ and $m = 1$.
The property of the operators T_F for $F \in D$ that their
only reducing manifolds are the space $L_p[0,c]$ for all
 $c \in [0,1]$ is crucial for the establishment of unitary in-
variants. A generalization of the case where there is no
restriction on p is described. A theorem is given illus-
trating the relevance of some of the differentiability con-
ditions imposed on $F(x,y)$.

MIN. 07:010

Minnesota U. Heat Transfer Lab., Minneapolis.

MASS-TRANSFER COOLING IN HIGH-SPEED LAMINAR
COUETTE FLOW, by E. R. G. Eckert and P. J. Schneider.
Apr. 1957, 42p. incl. illus. tables. (Technical rept. no.
12) (AFOSR-TN-57-186) (AF 18(600)1226) AD 126481
Unclassified

Theoretical results are presented on a study of high-
speed laminar Couette flow with injection of a lightweight
foreign gas. Solutions are given for the velocity, con-
centration, and temperature profiles in the flow between
two parallel porous plates, one of which is stationary and

MIN.07:011 - MIN.07:015

the other of which moves in its own plane with a constant velocity. The stationary plate is imagined to correspond to a single flat plate in boundary layer flow which is to be cooled by injection of a foreign gas through its porous surface. The Couette-flow results are used to derive expressions for the skin-friction coefficient, Nusselt number, recovery factor, and wall temperature for arbitrary injection rates and coolant reservoir temperatures. Specific calculations are made for cases of air-to-air, hydrogen-to-air, and helium-to-air injection under both isothermal and nonisothermal flow conditions, and these results are then compared directly with corresponding exact boundary-layer solutions. In all cases investigated, the agreement is close enough over a limited range of injection rates to recommend the simple calculation procedure based on Couette-flow for use in preliminary trajectory heat-transfer calculations required in the design of high-speed vehicles using the mass-transfer cooling method. (Contractor's abstract)

MIN.07:011

Minnesota U. Heat Transfer Lab., Minneapolis.

MASS TRANSFER COOLING OF A LAMINAR BOUNDARY LAYER BY INJECTION OF A LIGHT-WEIGHT FOREIGN GAS, by E. R. G. Eckert, P. J. Schneider and others. June 1957, 45p. incl. diagrs. tables. (Technical note no. 14) (AFOSR-TN-57-323) (AF 18-600)1226 AD 132395 Unclassified

Also published in Jet Propulsion, v. 28: 34-39, Jan. 1958.

Analytical predictions are given for the development of the velocity, temperature, and concentration fields in a laminar air boundary layer on a flat plate in high-speed dissipative flow, the plate being considered porous and cooled by injection of hydrogen from its surface. The admixture of hydrogen, having a low density and high thermal capacity relative to air, is shown to greatly diminish the skin friction and to markedly relieve the adverse thermal effects of intense aerodynamic heating under conditions of hypersonic flow.

MIN.07:012

Minnesota U. [Heat Transfer Lab.] Minneapolis.

MASS-TRANSFER COOLING OF A 20° POROUS CONE AT $M = 5$, by B. M. Leeson, C. J. Scott, and G. E. Anderson. July 1957 [48]p. incl. illus. diagrs. refs. (Research rept. no. 143) (AFOSR-TN-57-461) (AF 18-600)1226 AD 136452 Unclassified

Laminar recovery factor, local heat transfer, and surface concentration measurements have been conducted on a 20° porous cone at a nominal Mach number of 5 using both air and helium as the transpired gas. Measured heat transfer coefficients correlate well with the

theories of Low and of Baron when presented vs two modified blowing parameters chosen to account for the non-ideal permeability distribution. The laminar conical boundary layer was demonstrated to be quite stable at this Mach number both with zero injection and with air and helium injection. (Contractor's abstract)

MIN.07:013

Minnesota U. [Heat Transfer Lab.] Minneapolis.

TEMPERATURES AND THERMAL STRESSES IN TRANSPIRATION-COOLED POWER-PRODUCING PLATES AND TUBES, by P. J. Schneider. [1957] 8p. refs. (AF 18(600)1226) Unclassified

Published in Jet Propulsion, v. 27: 882-889, Aug. 1957.

Presentation of solutions for the local temperature, mean temperature, efficiency, surface-temperature difference, and thermal stress in transpiration-cooled, porous plates and tubes generating uniform distributed heat is made. Eight special cases are considered, four of which refer to the conventional case of the nongenerating, porous materials. (Contractor's abstract)

MIN.07:014

Minnesota U. [Heat Transfer Lab.] Minneapolis.

MASS TRANSFER COOLING IN A LAMINAR BOUNDARY LAYER IN STEADY TWO-DIMENSIONAL STAGNATION FLOW, by A. A. Hayday. Apr. 1958 [36]p. incl. illus. diagrs. (Technical note no. 19) (AFOSR-TN-58-337) (AF 18(600)1226) AD 154241 Unclassified

An analytical investigation of the effects of the hydrogen injection on flow and heat transfer characteristics near a stagnation point is set forth. Two dimensional, steady flow field with no chemical reactions taking place, is assumed. Results in the form of velocity, concentration, temperature, skin friction, and surface heat flux variations with injection are presented. It is found that under the stated conditions a high reduction in the heat transferred into the surface can be expected. (Contractor's abstract)

MIN.07:015

Minnesota U. [Heat Transfer Lab.] Minneapolis.

BOUNDARY LAYER TRANSITION WITH GAS INJECTION, by C. J. Scott and G. E. Anderson. July 1958 [28]p. incl. illus. diagrs. refs. (Research rept. no. 151) (AFOSR-TN-58-786) (AF 18(600)1226) AD 202112; PB 145740 Unclassified

Also published in Jour. Aero/Space Sciences, v. 25: 791, Dec. 1958.

MIN.07:016-018; MIN.17:001

Experiments were conducted on a porous 16° cone at Mach no. of 3.7 to ascertain the effects of gas injection on the stability of the laminar boundary layer. Observed zero-heat-transfer transition Reynolds numbers decrease with increased injection, but this effect was overcome by the cooling possible with injection. (Contractor's abstract)

MIN.07:016

Minnesota U. [Heat Transfer Lab.] Minneapolis.

MASS TRANSFER COOLING AT MACH NUMBER 4.8, by B. M. Leadon, C. J. Scott, and G. E. Anderson. [1958] [2]p. incl. diagrs. [AF 18(600)1226] Unclassified

Published in Jour. Aeronaut. Sciences, v. 25: 67-68, Jan. 1958.

Mass-transfer experiments on a 5 mil wire porous cone of 20° total angle have been conducted at $M_\infty = 4.8$ using air and helium injection. Details of the experimental technique are described in (item no. MIN.07:007; item no. MIN.07:012).

MIN.07:017

Minnesota U. [Heat Transfer Lab.] Minneapolis.

ANALYSIS OF A TRANSPIRATION-COOLED HEMI-SPHERE-CYLINDER, by C. J. Scott. Dec. 1957 [54]p. incl. diagrs. tables, refs. (Engineering memo. rept. no. 74) (AF 18(600)1226) Unclassified

Also published in Jour. Aeronaut. Sciences, v. 25: 397, June 1958.

An extension of the analysis of Stine and Wanlass ("Theoretical and Experimental Investigation of Aerodynamic-Heating and Isothermal Heat Transfer Parameters on a Hemispherical Nose with Laminar Boundary at Supersonic Mach Numbers," NACA Technical note no. 3344, Dec. 1954) is presented which predicts the effect of air injection on the heat transfer distribution over isothermal, blunt-nosed bodies of revolution. Only advance knowledge of the surface pressure distribution is required. Results are presented for a transpiration-cooled hemisphere-cylinder at a free-stream $M = 3.6$. The Mangler transformation and the Stewartson transformation were used to relate the problem in axisymmetric compressible flow, and then to an approximately equivalent two-dimensional incompressible flow where the thermal solutions of the Falkner-Skan wedge-flow cases were applied. The effects of the major assumptions; constant Prandtl number, small temperature differences, and local application of the Falkner-Skan solutions have already been discussed by Lees ("Laminar Heat Transfer over Blunt-Nosed Bodies at Hypersonic Flight Speeds," Jet Propulsion, v. 26, Apr. 1956). No additional assumptions are required to extend the analysis

to the case of air injection. The results display the distribution of local heat transfer parameter along the isothermal surface. The uniform decrease in local heat transfer coefficients with air injection is apparent. The value of the blowing parameter, f_w , varies with angular location and approaches asymptotically, as does the heat transfer parameter, the corresponding flat plate values. (Contractor's abstract, modified)

MIN.07:018

Minnesota U. Heat Transfer Lab., Minneapolis.

MASS TRANSFER COOLING WITH COMBUSTION IN A LAMINAR BOUNDARY LAYER, by J. P. Hartnett and E. R. G. Eckert. [1958] [15]p. incl. diagrs. table. [AF 18(600)1226] Unclassified

Published in Proc. Heat Transfer and Fluid Mech. Inst., California U., Berkeley (June 19-21, 1958), Stanford, Stanford U. Press, 1958, p. 54-68.

Mass transfer cooling is characterized by the fact that some material is released at the surface to be cooled and moves, at least partially, as a gas into the air flow passing the surface. The effectiveness of this method will be influenced by chemical reactions which may occur between the material released at the surface and the air. In order to evaluate this influence, a calculation is performed on a simplified model. Laminar boundary layer flow of the wedge type is considered, properties are assumed constant and equal for all components involved, infinite chemical reaction rate and equilibrium close to complete combustion is specified. Concentration and temperature profiles within the boundary layer, the position of the flame sheet and the heat flow rate to the surface are calculated. Numerical results are presented for some representative reactions. (Contractor's abstract)

MIN.17:001

Minnesota U. Hormel Inst., Austin.

INCLUSION COMPLEXES IN SOLUTION, by H. Schlenk. Technical status rept. no. 5, Feb.-May 1957, 5p. (AFOSR-TN-58-440) (AF 18(603)18) AD 158245 Unclassified

A comprehensive description of the preparation and testing of α - and β -cyclodextrin is presented with elaborations of a few changes made from the standard procedures in order to simplify or make those procedures more efficient.

MIN. 17:002, 003; MIN. 18:001, 002;
MIN. 19:001

MIN. 17:002

Minnesota U. Hormel Inst., Austin.

INCLUSION COMPLEXES IN SOLUTION, by H. Schlenk.
Technical status rept. no. 6, May-July 1957, 3p.
(AFOSR-TN-58-441) (AF 18(603)18) AD 158246
Unclassified

Experimental results of the molar ratio of α - and β -cyclodextrin in decanoic acid are given. A general method is presented to study the cyclodextrin molar ratios in fatty acids by means of a hydrolyzation of the dextrin to glucose and the use of Somogyi's procedure for the glucose determination.

MIN. 17:003

Minnesota U. Hormel Inst., Austin.

INCLUSION COMPLEXES IN SOLUTION, by H. Schlenk.
Technical status rept. no. 7, Aug.-Oct. 1957 [12]p. incl. diagrs. table. (AFOSR-TN-58-442) (AF 18(603)18)
AD 158247
Unclassified

The general study of molecular inclusion complexes of fatty acids in cyclodextrins is continued and brief reports are given on: the molecular ratios of host to guest molecules in solid dehydrated complexes of α - and β -cyclodextrins with fatty acids; and the stoichiometry of cyclodextrins in aqueous solutions of fatty acids.

MIN. 18:001

Minnesota U. Inst. of Tech., Minneapolis.

ON THE HÖLDER CONTINUITY OF QUASI-CONFORMAL AND ELLIPTIC MAPPINGS, by R. Finn and J. Serrin. June 11, 1957 [24]p. (AFOSR-TN-57-355) (In cooperation with Calif. Inst. of Tech., Pasadena) (AF 18(603)31) AD 132428
Unclassified

Also published in Trans. Amer. Math. Soc., v. 89: 1-15, Sept. 1958.

A simple new proof is presented of the Hölder continuity of quasi-informal mappings which shows that the Hölder constant can be chosen independent of K , a positive constant less than infinity such that $u_x^2 + u_y^2 + v_x^2 + v_y^2 \leq 2K(u_x v_y - u_y v_x)$; $u(x,y)$ and $v(x,y)$ are continuously differentiable functions defined in a domain of the complex z -plane, $z = x + iy$. A more general class of mappings is treated which satisfy an inequality of the form $u_x^2 + u_y^2 + v_x^2 + v_y^2 \leq 2K(u_x v_y - u_y v_x) + K_1$, where K and K_1 are constants $K \geq 1$ and $K_1 \geq 0$. The following result on Hölder continuity of elliptic mappings is proved: Let $w = u + iv$ be an elliptic mapping defined

in a domain A of the z -plane, and assume that $|w| \leq 1$ and $K > 1$; then in any compact subregion B of A , the function $w(z)$ satisfies a uniform Hölder inequality $|w(z_1) - w(z_2)| \leq H|z_1 - z_2|^\mu$, where $\mu = K - \sqrt{K^2 - 1}$ and H depends only on K , K_1 and the distance from B to the boundary of A . Extension of the results is made to the case where w is undefined or not differentiable at isolated points of A but otherwise satisfies the same hypotheses. A close analog is also proved of the Riemann theorem on removable singularities of analytic functions. One-to-one quasi-informal mappings are considered of a domain A onto a domain B , showing that if A and B have sufficiently smooth boundaries, then any such mapping can be extended so that it is one-to-one and continuous in the closure \bar{A} of A , and thus extended, it satisfies a uniform Hölder condition over all of \bar{A} with constants depending in a simple way on A , B , and K . All results remain true for the more general mappings.

MIN. 18:002

Minnesota U. Inst. of Tech., Minneapolis.

ON A FUNDAMENTAL THEOREM OF THE CALCULUS OF VARIATIONS, by J. Serrin. Aug. 15, 1958 [29]p. incl. refs. (AFOSR-TN-58-458) (AF 18(603)31)
AD 158265; PB 136488
Unclassified

Also published in Acta Math. v. 102: 1-22, 1959.

A reformulation is given of Hilbert's theorem which states that if the extremal ϵ can be imbedded in a field \mathcal{F} with slope functions $p(x,y,z)$, $q(x,y,z)$ such that the Weierstrass function obeys $E(\epsilon, y, z; p, q; P, Q) \geq 0$ for each set of values (x, y, z) in the field, then ϵ minimizes the integral $I[u] = \int_R F(x, y, u, p, q) dA$ relative to all admissible functions whose values lie in the field. In the new formulation, it is assumed that there is at least one admissible function which gives I a finite value, and the field is required to be an extremal field. On the other hand, by virtue of an extension of the notion of imbedding, it has not been necessary to make any assumption concerning the behavior of ϵ at the boundary, beyond simply requiring that it take on the given boundary values. The proof is a modification and extension of Hilbert's classical argument; at no stage is it necessary to resort to deep theorems of integration or functional analysis. Finally the proof applies equally in n dimensions and to extremals satisfying only the Haar equations.

MIN. 19:001

Minnesota U. Inst. of Tech., Minneapolis.

THE DERIVATION OF STRESS-DEFORMATION RELATIONS FOR A STOKESIAN FLUID, by J. Serrin. Jan. 20,

MIN. 19:002; MIN. 09:011, 012;
MIN. 20:001

1959, 16p. incl. refs. (AFOSR-TN-58-1085)
(AF 49(638)262) AD 207582; PB 140134 Unclassified

Also published in Jour. Math. and Mech., v. 8: 459-569,
July 1959.

A simple and complete treatment is given of the constitutive equation where the stress tensor is a function of the deformation tensor (Stokesian fluid). A set of conditions is stated concerning the reaction of the fluid to deformation and from these conditions (and these alone), the form of the constitutive equation follows. The algebraic details are presented with the main results being stated in the form of 2 theorems. A simple proof of the Newton-Cauchy-Poisson law is included. The concept of fluid pressure is discussed and clarified. (ASTIA abstract)

MIN. 19:002

Minnesota U. Inst. of Tech., Minneapolis.

POISEUILLE AND COUETTE FLOW OF NON-NEWTONIAN FLUIDS, by J. Serrin. Jan. 20, 1959 [12]p. incl. diagrs. (AFOSR-TN-58-1087) (AF 49(638)262) AD 207584; PB 140043 Unclassified

Also published in Zeitschr. Angew. Math. Mech. (ZAMM) v. 39: 295-299, July-Aug. 1959.

Two exact solutions corresponding to Poiseuille and Couette flow are discussed of the equations: (1)

$T = \alpha I + \beta D + \gamma D^2$, where T is the stress tensor, D is the rate-of-deformation tensor, and α, β, γ are certain scalar coefficients; and (2) $\rho a = \rho f + \text{div } T$, where a is the acceleration vector and f is the gravitational force. The physical nature of these solutions are clarified, and these similarities and differences with the classical solutions are pointed out. (ASTIA abstract)

MIN. 09:011

Minnesota U. Rosemount Aeronautical Labs., Minneapolis.

RESEARCH ON LAMINAR AND TURBULENT BOUNDARY LAYERS AT SUPERSONIC SPEEDS, by W. S. Bradfield. Final summary rept. Dec. 1957, 236p. incl. illus. diagrs. tables, refs. (Research rept. no. 131) (AFOSR-TR-57-64) (AF 18(600)384) AD 136559 Unclassified

A synthesis is presented of results obtained in research under the writer's direction on cone boundary layers in the moderate Mach number range ($1 < M_\infty < 6$). Included are laminar and turbulent boundary layer investigations of friction and heat transfer; some effects on boundary layer development of a shockwave at the boundary layer origin; some effects of yaw on boundary layer development; a discussion of possible probe er-

rors; design, development, and application of a boundary layer total temperature probe; and a description of a new schlieren apparatus suitable for study of compressible flow details. (Contractor's abstract)

MIN. 09:012

Minnesota U. Rosemount Aeronautical Labs, Minneapolis.

SOME EXPERIMENTS ON EFFECTS OF YAW ON BOUNDARY-LAYER DEVELOPMENT IN SUPERSONIC CONE FLOW, by D. G. DeCoursin and W. S. Bradfield. [1958] [3]p. incl. diagrs. (AF 18(600)384) Unclassified

Published in Jour. Aero/Space Sciences, v. 25: 662-664, Oct. 1958.

This paper is a summary of a study of the effect of small angles of yaw on boundary-layer development on a cone including turbulent boundary-layer data previously obtained in connection with a more general experimental program. Presentation is made of the following: (1) effects of yaw on laminar velocity profiles on the windward surface of a 15° cone at $M_\infty = 2.73$; (2) effect of yaw on velocity profiles on the leeward surface at a 15° cone at $M_\infty = 2.73$; (3) effect of variation of Reynolds number at constant yaw; (4) effect of variation in yaw at constant Reynolds number; and (5) effect of yaw on local skin friction coefficient for laminar flow over a 15° cone at $M_\infty = 2.73$. A comparison of these experimental results with theoretical analyses is shown.

MIN. 20:001

Minnesota U. Rosemount Aeronautical Labs., Minneapolis.

THE COMBUSTION CHANNELS OF THE PROPULSION RESEARCH LABORATORY, by C.-C. Chang and D. G. DeCoursin. Mar. 1958, 20p. illus. diagrs. (Research rept. no. 149) (AF 18(600)1553) AD 152247 Unclassified

A description of the combustion channels of the Propulsion Research Lab. is presented. The major equipment consists of two channels with test section sizes $2 \times 1 \times 12$ in. and $4 \times 6 \times 20$ in. At present subsonic test sections are installed which permit velocities up to choking and pressure level variation from 3 in. Hg to atmospheric. Modification of the test section windows would permit operation at pressures up to 3 atm. With the proper test section supersonic flow up to approx. $M = 5$ could be obtained. The facility has been designed for maximum flexibility and operation over wide pressure and velocity ranges. Some experimental flame blowoff data is

MIN.20:002, 003; MIN.21:001;
MIN.12:011

presented which is in good agreement with similar data obtained by Haddock at Jet Propulsion Lab. Simultaneous horizontal and vertical schlieren photographs are also presented.

the present one is explained. Acoustic impedance for the external diffusion region is also obtained, which indicates that flow in the supersonic inlet-diffuser is intrinsically stable in the absence of viscous dissipation. (Contractor's abstract)

MIN.20:002

Minnesota U. Rosemount Aeronautical Labs.,
Minneapolis.

ON THE AERODYNAMIC INSTABILITY OF SUPER-SONIC INLET-DIFFUSERS, by C.-C. Chang and C.-T. Hsu. Jan. 19, 1959, 1v. incl. diagrs. refs. (Research rept. no. 155) (AFOSR-TN-58-887) (AF 18(600)1553) AD 204099; PB 140547 Unclassified

Also published in ARS Jour., v. 30: 468-475, May 1960.

The stability problem of the supersonic inlet-diffuser is first reduced to find the acoustic impedance at the inlet of the plenum chamber. The inlet acoustic impedance is then obtained by solving the linearized viscous compressible flow equations in the entire subsonic regimes. These solutions satisfy Burger's boundary conditions behind the oscillating shock. Essential assumptions of one-dimensional quasi-steady flow and linear velocity distribution are used. It is found that the self-excited shock oscillation is not possible in absence of viscous dissipation. Flow instability is found due to further entropy generated by viscous dissipation in addition to shock oscillation. Neutral stability boundaries are obtained in terms of the ratio of perturbation entropy to the corresponding shock velocity and are in agreement with Stoolman's experimental data. The present analysis confirms Trimp's theory of instability and also justifies the Stenbentz-Evvard's theory in the range of "steady" subcritical operation. (Contractor's abstract)

MIN.20:003

Minnesota U. Rosemount Aeronautical Labs.,
Minneapolis.

SOLUTIONS TO STOOLMAN'S EXTERNAL DIFFUSION EQUATION FOR INSTABILITY OF A NORMAL SHOCK INLET DIFFUSER, by C.-C. Chang and C.-T. Hsu. [1958] [4]p. incl. diagrs. (AFOSR-TN-58-888) (AF 18(600)1553) AD 204098 Unclassified

Published in Jet Propulsion, v. 28: 457-460, July 1958.

Simple approximate solutions for the external diffusion regime of a normal shock inlet diffuser in subcritical operation are obtained in analytical forms. These solutions correspond to Stoolman's original differential equations in the external diffusion regime with an additional assumption of linear axial velocity variation. The solutions satisfy the upstream boundary conditions of flow perturbations immediately behind the oscillating shock. Deviation of Stoolman's numerical result from

MIN.21:001

Minnesota U. Rosemount Aeronautical Labs.,
Minneapolis.

A TECHNIQUE FOR EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER FROM A SURFACE IN SUPER-SONIC FLOW AT LARGE SURFACE-TO-FREE-STREAM TEMPERATURE RATIOS, by W. S. Bradfield, A. R. Hanson and others. June 1958, 1v. incl. illus. diagrs. tables. (Research rept. no. 150) (AFOSR-TR-58-64) (AF 18(603)16) AD 158252; PB 144952 Unclassified

An experimental technique is reported for studying problems of heat transfer at high surface temperatures and high surface-to-free-stream temperature ratios. The heat flux direction, from the surface to the boundary layer, is in contrast with that usually encountered in flight. With the apparatus developed it has been possible to produce a moderately hot surface in a cooling gas stream which is chemically homogeneous and of known composition and to make measurements of surface temperature, heat flux, and the rate of loss of mass. Preliminary values of local convective and radiative heat transfer at surface temperatures as high as 3440°R have been determined. Maximum surface temperatures reached in a stagnant inert atmosphere have exceeded 6200°R, and in a Mach 2.3 free jet they have gone as high as 4700°R. The highest heat flux measured was 333

BTU/ft²-sec at a surface temperature of 3300°R. The maximum surface-to-free-stream temperature ratio was 20. Some studies were made on the deterioration of graphite surfaces coated with silicon nitride and silicon carbide. (Contractor's abstract, modified)

MIN.12:011

Minnesota U. [School of Chemistry] Minneapolis.

ELECTRON SPIN RESONANCE OF IMPURITIES IN MAGNESIUM OXIDE (Abstract), by J. E. Wertz, J. L. Vivo, and B. Musulin. [1955] [1]p. [AFOSR-TN-55-433] [AF 18(600)479] Unclassified

Presented at meeting of the Amer. Phys. Soc., Southern California U., Los Angeles, Dec. 28-30, 1955.

Published in Buil. Amer. Phys. Soc., v. 30: 26, Dec. 28, 1955.

All magnesium oxide crystals that have been located show a six-line hyperfine splitting pattern found previously upon deliberate addition of manganese. Technical MgO

MIN.12:012 - MIN.12:014

powder shows the same behavior as does also a reagent grade which has been heated to 1200°C. Their line width is as small as 1.5 gauss, very narrow for an ionic crystal, and much narrower than found previously (Phys. Rev., v. 88: 714, 1952). The fourth line (counting from the low field end) shows unusually large variations of intensity relative to the other five. Each of the principal lines has four satellites, explainable for an electronic spin of 5/2. At high spectrometer sensitivity, a number of weak lines are found in pairs. Their origin is being investigated. Heating to 200°C in the resonant cavity of the spectrometer decreases the ESR line intensity by an amount expected from Curie's law. An impurity of nuclear spin 7/2 and electronic spin of 3/2 gives 8 principal lines over a 560 gauss region. Each has 2 satellites.

MIN.12:012

Minnesota U. School of Chemistry, Minneapolis.

CRYSTAL VACANCY EVIDENCE FROM ELECTRON SPIN RESONANCE, by J. E. Wertz and P. Auzins. [1957] [15]p. incl. diagrs. ([AF]OSR-TN-57-103) (AF 18(600)-479) AD 120453 Unclassified

Also published in Phys. Rev., v. 106: 484-488, May 1, 1957.

Three distinct patterns have been observed in the electron spin resonance spectrum of chromium (+3) ions in single crystals of magnesium oxide. The chromium (present in naturally-occurring amounts or augmented) replaces magnesium (+2) ions substitutionally. The Cr(+3) spectrum depends upon whether compensation for the extra charge occurs in the immediate vicinity, and if so, upon the position of the compensating charge. The first pattern is a single line surrounded by a hyperfine quartet, representing that expected for a F ion in a purely cubic electric field if most of its isotopes have zero nuclear spin I , and one isotope has $I = 3/2$. This means that charge compensation cannot occur in a position as close as that of the next-nearest magnesium ion. The second pattern has 9 lines (each with a hyperfine quartet), the angular dependence of which shows axial symmetry about the principal crystal axes. It is explained in terms of a vacancy in the magnesium position next-nearest the chromium ion. The third pattern arises from ions with axes of symmetry in face-diagonal ([110]-type) directions. This symmetry is ascribed to the effects of a magnesium ion vacancy in a position nearest the central ion. (Contractor's abstract)

MIN.12:013

Minnesota U. School of Chemistry, Minneapolis.

ELECTRON SPIN RESONANCE OF F CENTERS IN MAGNESIUM OXIDE; CONFIRMATION OF THE SPIN OF MAGNESIUM-25, by J. E. Wertz, P. Auzins and

others. [1957] [3]p. incl. diagrs. refs. (AFOSR-TN-57-401) (AF 18(600)479) AD 132479 Unclassified

Also published in Phys. Rev., v. 107: 1535-1537, Sept. 15, 1957.

An electron spin resonance (ESR) spectrum induced in magnesium oxide crystals by pile irradiation has been interpreted as arising from F centers. After an oxide ion is displaced from its normal position by neutrons, an electron donated by ever-present divalent impurities may become trapped at the vacancy. Those centers having only Mg^{24} and Mg^{26} neighbors give a single ESR line with $g = 2.0023$, while those with one or more Mg^{25} neighbors give hyperfine patterns corresponding to the nuclear spin value of 5/2. The magnitudes of the isotropic and anisotropic parts of the hyperfine interaction show strong localization of the electron in the vacancy. (Contractor's abstract)

MIN.12:014

Minnesota U. [School of Chemistry] Minneapolis.

IMPURITY - CONTROLLED ELECTRONIC PROPERTIES OF MAGNESIUM OXIDE (Abstract), by J. E. Wertz, J. L. V. Acrivos, and P. Auzins. [1957] [1]p. [AF 18(600)479] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 185, Apr. 25, 1957.

The large energy gap between the valence and conduction bands in MgO crystals causes impurities to play a controlling role in determining such electronic properties as the absorption spectrum, electrical- and photoconductivity and the luminescence behavior. It is extremely difficult to prepare crystals which do not contain transition elements in amounts which are readily detectable by their electron spin resonance absorption. Of those commonly present, iron and chromium are probably the most important, though manganese and vanadium often play a role. Their ability to exist in either of two stable valence states insures the presence of numerous filled or empty levels in the energy gap. Valence changes are readily detected after such treatments as heating in vacuum, in oxygen or magnesium vapors or ultraviolet or x-irradiation. After some of these an apparently stable state is reached, while especially for radiation, numerous changes occur in decay processes. The pattern of electron transfer among the several impurities serves as a guide to locate relatively the energy levels. In some processes one merely requires a redistribution of the existing positive ion vacancies, while in others they are formed or destroyed. Identification of the spectrum of Cr(+3) with an associated vacancy has permitted the observation of changes in association.

MIN. 12:015, 016; MIN. 13:002, 003;
MIN. 22:001

MIN. 12:015

Minnesota U. School of Chemistry, Minneapolis.

EFFECT OF ENVIRONMENT ON THE FLUORINE MAGNETIC RESONANCE IN SOLUTIONS OF POTASSIUM FLUORIDE, by A. Carrington and T. Hines. [1958] [2]p. incl. table. (AFOSR-TN-58-318) (AF 18(600)479) AD 234952 Unclassified

Also published in Jour. Chem. Phys., v. 28: 727-728, Apr. 1958.

The polarization of the F ion has been studied as a function of the concentration of the organic solvent, solution temperature, and the presence of other electrolytes in the solution by means of the diamagnetic shielding produced at the F nucleus. Nuclear magnetic resonance spectra of KF solutions in organic solvents have been obtained which indicate that the higher magnetic fields necessary to produce resonance as concentration or temperature is increased or as a series of solvents are used, can be interpreted on the basis of hydrogen bonding.

MIN. 12:016

Minnesota U. School of Chemistry, Minneapolis.

ELECTRON SPIN RESONANCE STUDIES OF UNIVALENT AROMATIC HYDROCARBON IONS, by A. Carrington, F. Dravnieks, and M. C. R. Symons. [1958] [15]p. incl. diagrs. tables, refs. (AFOSR-TN-58-689) (AF 18(600)479) AD 162223 Unclassified

Also published in Jour. Chem. Soc. (London), No. 192, p. 947-952, Mar. 1959.

The electron spin resonance spectra of positive and negative ions of anthracene, naphthalene, and perylene have been analyzed to yield the resolved hyperfine structure. Precise values of the splitting constants have been assigned and in the case of the ions formed in sulphuric acid solutions, the spectra have been shown to be unambiguously interpreted in terms of a single paramagnetic species. The density of electrons at the various carbon positions in the hydrocarbons has been determined and compared with values calculated by use of the Hückel molecular orbit theory. Some aspects of the chemistry of the positive hydrocarbon ions are discussed.

MIN. 13:002

Minnesota U. [School] of Chemistry, Minneapolis.

A STUDY OF THE MECHANISM OF THE REACTIONS USED IN THE PREPARATION OF DIHALODISTANNANE AND AN ATTEMPT TO PREPARE POLYMERS FROM DICHLOROTETRABUTYLDISTANNANE, by O. H.

Johnson. Oct. 15, 1957 [26]p. incl. tables, refs. (AFOSR-TR-57-82) (AF 18(600)984) AD 136654 Unclassified

The following subjects are presented: (1) Evidence for the existence of compounds of the type $\text{Cl-Sn(R}_2\text{)Sn(R}_2\text{)Cl}$; (2) Experimental preparation of tetraalkyldihalodistannanes in general; (3) Properties and reactions of dichlorotetraalkyldistannane compounds; (4) Attempted polymer formation by means of the Wurtz reaction; (5) Reaction of $(\text{C}_4\text{H}_9)_4\text{Sn}_2\text{Cl}_2$ with Na in liquid NH_3 ; (6) Reaction of $\text{R}_4\text{Sn}_2\text{Cl}_2$ with organic bases; (7) Attempted reaction of Al_4C_3 with SnCl_4 ; (8) Reduction of $(\text{C}_4\text{H}_9)_4\text{Sn}_2\text{Cl}_2$ with LiAlH_4 ; (9) Reaction with 1,5-dibromopentane Grignard reagent; (10) Methylenation with CH_2N_2 ; (11) Preparation of Thiokol-type rubber; and (12) Preparation of 1,1-diethoxy-3-(triphenylstannyl)-2-propyne.

MIN. 13:003

Minnesota U. [School] of Chemistry, Minneapolis.

1,1-DIETHOXY-3-(TRIPHENYLSTANNYL)-2-PROPYLENE, by O. H. Johnson and J. R. Holum. [1958] [3]p. incl. refs. (AF 18(600)984) Unclassified

Published in Jour. Org. Chem., v. 23: 738-740, May 1958.

This acetylenic organotin compound containing a potential aldehyde was synthesized by the action of the Ag salt of propionaldehyde diethylacetal, II, on triphenyltin bromide, I. Its structure was assigned on the basis of origin and analytical data. In determining the compound's properties it was found that the Sn-C bond in which the carbon atom is part of the acetylenic linkage is easily broken.

MIN. 22:001

Minnesota U. [School of Chemistry] Minneapolis.

INTERACTIONS OF CHLOROPHYLL IN ITS TRIPLET STATE WITH OXYGEN, CAROTENE, ETC., by E. F. Fujimori and R. Livingston. Aug. 1957, 7p. incl. tables, refs. (AFOSR-TN-57-510) (AF 18(600)1485) AD 136496 Unclassified

Also published in Nature, v. 180: 1036-1038, Nov. 16, 1957.

To test the postulate that the triplet state of chlorophyll is involved in the photosynthesis of green plants, the half life of the triplet state of chlorophyll was measured in various compounds. The materials were (1) analytical-reagent-grade solvents distilled at least once out of contact with air, (2) vacuum-distilled cyclooctatetraene, (3) sublimed quinone, (4) fractionally crystallized reductants, (5) carotenes and xanthophylls purified chromatographically on MgO columns and (6) purified chlorophylls.

MIN. 22:002; MIN. 23:001; MIS. 01:010

Kinetic measurements were made with a flash-photolytic apparatus and a scanning beam of constant intensity which was rendered approximately monochromatic by means of interference filters. More than 70% of the chlorophyll molecules were excited to the triplet state by light from an unfiltered flash; orange filters reduced the conversion to 20%. The half lives observed for 1.5×10^{-6} M solutions of chlorophyll a in benzene containing p-benzoquinone ranged from 4.05 to 1.58 sec $\times 10^4$ at quinone concentrations of 0 to 15.0 M $\times 10^7$. Oxygen and quinone were efficient quenchers of the triplet states of sensitizers, with bimolecular quenching constants of 1.1 ± 0.3 and 2.4 ± 0.5 M $^{-1}$ sec $^{-1} \times 10^{-9}$, respectively. Cyclo octotetraene was moderately efficient with a constant of 0.0012 ± 0.0002 M $^{-1}$ sec $^{-1} \times 10^{-9}$. β -Carotene, α -carotene, and xanthophyll were as efficient as O in quenching the triplet state of chlorophyll a. (Contractor's abstract)

MIN.22:002

Minnesota U. [School of Chemistry] Minneapolis.

A STUDY OF THE TRIPLET STATE OF ANTHRACENE IN LIQUID SOLUTIONS, by R. Livingston and D. W. Tanner. [1957] [19]p. incl. diagrs. tables. (AFOSR-TN-57-680) (AF 18(600)1485) AD 136669

Unclassified

Also published in Trans. Faraday Soc., v. 54: 765-771, June 1958.

The half-life of the triplet state of anthracene has been measured in several air-free solvents at ambient temperatures. The following values were obtained: 90% C₇H₁₆ + 10% CS₂, 200; C₆H₅Br, 430; C₆H₅Cl, 790; "liquid petrolatum", 1100; and glycerol 9400 μ sec. The quenching of the triplet state by added reactants has been studied in bromobenzene. The values for the bimolecular rate constants are as follows: O₂, 2.0×10^9 ; benzoquinone, $\approx 2 \times 10^7$; CHCl₃, 3.2×10^3 ; and CS₂, $< 5 \times 10^2$ M $^{-1}$ sec $^{-1}$. (Contractor's abstract)

MIN.23:001

Minnesota U. School of Chemistry, Minneapolis.

EQUATIONS FOR THE LIMITING CURRENT AT THE ROTATED DROPPING MERCURY ELECTRODE, by I. M. Kolthoff and Y. Okinaka. Final rept. Aug. 15, 1957 [14]p. incl. diagrs. tables, refs. (AFOSR-TN-57-337) (AF 18(600)1516) AD 132411

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 3326-3339, July 5, 1957.

Results are described of a theoretical and experimental study of the relationship between the limiting current at the rotated dropping mercury electrode on the one hand and the diffusion coefficient of the electroactive species, the kinematic viscosity of the solution, and the characteristics of the electrode on the other. Two theoretical equations are derived on the basis of hydrodynamics, one for the case when no surface-active substance is present and the other for the case when such substances are present. In view of the fact that the presence of a suitable surface-active substance is necessary for most practical purposes, the relations in the presence of a capillary-active substance were studied more extensively than those in its absence. The proposed equation in the presence of surface-active compounds involves an experimentally determined numerical constant and yields satisfactory agreement between observed and calculated limiting currents in the range of 75 to 210 rpm, provided that an electrode of the proper dimensions is employed. At a suitable speed of rotation in the presence of a surface-active substance, the limiting current at the rotated dropping mercury electrode, as a first approximation, is proportional to $D^{2/3}(\eta t)^{1/2}$ while at the unrotated conventional dropping mercury electrode it is proportional to $D^{1/2} \eta^{2/3} t^{1/6}$. Limitations of the derived equations are discussed both from theoretical and practical viewpoints. (Contractor's abstract)

MIS.01:010

Missouri U. Dept. of Mathematics, Columbia.

UNIFORM CONSISTENCY OF ESTIMATORS OF LINEARLY ORDERED PARAMETERS, by H. D. Brunk. Aug. 1957, 13p. refs. (Technical rept. no. 9) (AFOSR-TN-57-516) (AF 18(600)1108) AD 136501

Unclassified

The following problem of estimation is considered: Let k be a positive integer. To each positive integer $1 \leq k$ corresponds a population whose distribution is known except for the unknown value of its mean θ_1 ; the means satisfy certain inequalities. The problem of estimating a distribution function from all-or-none data (bioassay) is of this kind, in which the populations are binomial and the inequalities are of the form $\theta_1 \leq \theta_2 \leq \dots \leq \theta_k$. Even if the populations are not binomial but all belong to a common exponential family, the maximum likelihood estimators (MLE's) subject to $\theta_1 \leq \theta_2 \leq \dots \leq \theta_k$ are determined as follows: Let \bar{x}_i be the sample mean of a sample of size n_i from the i^{th} population whose mean is θ_i , $i = 1, 2, \dots, k$. If $\bar{x}_1 \leq \bar{x}_2 \leq \dots \leq \bar{x}_k$, these are the MLE's of the parameters θ_i , $i = 1, 2, \dots, k$. If for some i , $\bar{x}_i > \bar{x}_{i+1}$, these 2 means are replaced by the single ratio $(n_i \bar{x}_i + n_{i+1} \bar{x}_{i+1}) / (n_i + n_{i+1})$, obtaining an ordered set of only $k-1$

MIS.01:011 - MIS.01:014

ratios, $k-2$ of which are sample means. This procedure is repeated until an ordered set of ratios is obtained which are monotone nondecreasing. Then for each i , the MLE, $\hat{\theta}_i$, of θ_i is equal to that one of the final set of ratios to which the original ratio \bar{x}_i contributed. If the number, k , of observation points is held fixed while the number of observations at each point increases indefinitely, classical theory assures the strong consistency of the $\hat{\theta}$ and yields their asymptotic distribution; the $\hat{\theta}$ will asymptotically coincide with the sample means. Mainly cases of a large number of observation points, but only a few observations, are considered.

MIS.01:011

Missouri U. Dept. of Mathematics, Columbia.

MAXIMIZING THE SUM OF CONCAVE FUNCTIONS, by M. C. Ayer. Aug. 1957, 27p. (Technical rept. no. 10) (AFOSR-TN-57-549) (AF 18(600)1108) AD 136533
Unclassified

Special cases of linear and nonlinear programming are considered. Solutions are developed to problems of the following type: Find each point $x = (x_1, x_2, \dots, x_n)$

of E_n to maximize $\sum_{i=1}^n f_i(x)$ under the restriction that

x be contained in the set of points of the plane

$\sum_{i=1}^n k_i x_i = K$ where the component x_i lies in a given

interval from a_i to b_i , $i = 1, 2, \dots, n$. The investigation is limited to the case where $f_i(u)$ is concave and differentiable, $i = 1, 2, \dots, n$. Examples are given to illustrate the procedure.

MIS.01:012

Missouri U. Dept. of Mathematics, Columbia.

MINIMIZING INTEGRALS IN CERTAIN CLASSES OF MONOTONE FUNCTIONS, by H. D. Brunk, G. M. Ewing, and W. R. Utz. 1957 [15]p. (AFOSR-TN-57-665) [AF 18(600)1108] AD 136677
Unclassified

Also published in Pacific Jour. Math., v. 7: 833-847, Spring, 1957.

Let R_n be the space of points $t = (t^1, \dots, t^n)$, μ a totally finite, complete measure on R_n , and $\sigma(t)$ a measurable real-valued function. Let F be a real-valued function on R_2 satisfying: (1) $F(\sigma(t), \theta(t))$ is measurable if $\theta(t)$ is; (2) for fixed u , $F(u, v)$ is strictly decreasing (increasing) in v for $v \leq u$ ($v \geq u$) and right (left) continuous in v for $v < u$ ($v > u$); (3) $\int F(\sigma(t), \sigma(t)) d\mu(t) < \infty$. Let $J(\theta) = \int F(\sigma(t), \theta(t)) d\mu(t)$. The existence is shown of functions

minimizing $J(\theta)$ for θ in two classes of monotone functions. One class consists of those $\theta(t)$ which are nondecreasing in each component of t and for which all of the second differences, obtained from pairs of components, are negative. Representation and uniqueness theorems are also proved. The problem is connected with that of obtaining a maximum likelihood estimate of a distribution function. (Math. Rev. abstract)

MIS.01:013

Missouri U. Dept. of Mathematics, Columbia.

PROPERTIES OF SOLUTIONS OF CERTAIN SECOND ORDER NONLINEAR DIFFERENTIAL EQUATIONS, by W. R. Utz. [1957] [5]p. (AF 18(600)1108) Unclassified

Published in Proc. Amer. Math. Soc., v. 8: 1024-1028, Dec. 1957.

Theorems on the boundedness of solutions of second order nonlinear differential equations are used as a starting place for a more detailed examination of the behavior of solutions of such equations for large values of the independent variable. The boundedness theorems cited give sufficient conditions for the existence of constants $A, B > 0$ such that if $x = x(t)$ is a solution of the given equation valid for all large t , then $x(t) < B$ for all $t > A$ where A and B may depend upon the particular solution $x = x(t)$. Theorems which guarantee $A, B > 0$, as above, but in which B is independent of the solution selected, have been used to show the existence and uniqueness of periodic solutions. If $d > 0$ and $e > 0$ are real constants, then a solution $x = x(t)$, $x(t) \neq 0$ of the linear equation $x'' + dx' + ex = 0$ is oscillatory or monotonically approaches zero. The theorems secured in this paper may be thought of as generalizations of this remark. In section 2 the theorems proved in the paper are stated and in section 3 the proofs of the theorems are provided. (Contractor's abstract)

MIS.01:014

Missouri U. Dept. of Mathematics, Columbia.

SOME ASPECTS OF UNSTABLE HOMEOMORPHISMS, by J. F. Jakobsen and W. R. Utz. Nov. 1958, 19p. (Technical rept. no. 10) (AFOSR-TN-58-1040) (AF 18(600)1108) AD 206574; PB 136353
Unclassified

The existence of asymptotic orbits in the presence of unstable self-homeomorphisms is discussed. A proof is given of Schwartzman's theorem which states that if x is compact and non-trivial and $T(x) = x$ is an unstable homeomorphism, then there exists at least a pair of positively asymptotic orbits and at least a pair of negatively asymptotic orbits. Williams' paper on unstable homeomorphism of a continuum [Proc. Amer. Math. Soc., v. 6: 308-309, 1955] is discussed and criticized. (ASTIA abstract)

MIS.01:015, 016; MOD.01:001;
MOR.01:001; MZH.01:001

MIS.01:015

Missouri U. Dept. of Mathematics, Columbia.

MATHEMATICAL MODELS FOR RANKING FROM
PAIRED COMPARISONS, by H. D. Brunk. Nov. 1958,
33p. (Technical rept. no. 11) (AFOSR-TN-58-1041)
(AF 18(600)1108) AD 206573 Unclassified

Also published in Jour. Amer. Statist. Assoc., v. 55:
503-520, Sept. 1960.

There are m items to be compared in pairs. S_{ij} is a random variable which measures the score on the comparison of the i th item with the j th. It is assumed that $S_{ij} + S_{ji} = 1$, the conventional situation being one in which the score has only two possible values, 0 and 1. To say that the m items are "ranked" means that a permutation, $R(1), \dots, R(m)$ of the integers $1, \dots, m$ is assigned. Let $e_{ij} = ES_{ij}$ and let $e^{ij} = e_{R(i)R(j)}$. A "utility of a ranking" is defined to be a function of the scores e^{ij} which is nondecreasing in its arguments, and an "optimum ranking" is one which maximizes this function. The spirit of the paper is to unify the many special cases discussed in the literature; many specific kinds of utility functions are examined, analogies with the analysis of variance are exploited and certain technical aspects of utility functions are examined mathematically. (Math. Rev. abstract)

MIS.01:016

Missouri U. [Dept. of Mathematics] Columbia.

ON THE ESTIMATION OF PARAMETERS RESTRICTED
BY INEQUALITIES, by H. D. Brunk. [1958] [18]p. Incl.
refs. (AF 18(600)1108) Unclassified

Published in Ann. Math. Stat., v. 29: 437-454, June 1958.

Remarks on the minimization of convex functions subject to side conditions are given, together with a discussion of the uniform consistency of estimators of linearly ordered parameters. The problem of minimizing a function of several variables is considered, which is subject to side conditions which specify that the variables must satisfy certain inequalities. The maximum likelihood estimation (MLE) of the one-parameter k populations is given. Each one also belongs to an "exponential family". Methods of finding the minimizing point on a given intersection of boundaries of restricting sets are discussed. A sufficiency property related to the MLE's is considered.

MOD.01:001

Modena U. (Italy).

[ELECTROCHEMICAL BEHAVIOR OF HYDROGEN

PEROXIDE AND OXYGEN ON GRAPHITE ELECTRODES]
Comportamento elettrochimico dell'acqua ossigenata e dell'ossigeno su elettrodi di grafite, by G. Bianchi, G. Caprioglio and others. [1958] [5]p. Incl. diags. (AF 61-052)85 Unclassified

Presented at Eighth Nat'l. Congress of Chem., Torino (Italy), May 27-June 3, 1958.

Published in Chimica e Industria, v. 40: 822-826, Nov. 1958.

The authors have effected a measurement of the anode and cathode polarization on a graphite electrode in various pH solutions, circulating O_2 or CO_2 and varying concentrations of H_2O_2 from 0 to 10^{-1} mol/l. The results have been interpreted considering the intervention of the electromotive processes initiating CO and CO_2 adsorption on the electrode. Such processes can be substituted or superimposed for H_2O_2 and O_2 , particularly in the case of acid solutions.

MOR.01:001

Morton Chemical Co., Woodstock, Ill.

ORGANIC POLYMERS CONTAINING ALUMINUM AND
TITANIUM, by R. L. Frank, A. A. Baldoni, and T. R. Patterson, Jr. Jan. 1958, 8p. Incl. diags. tables.
(AFOSR-TR-58-18) (AF 18(600)1599) AD 148137 Unclassified

The formation and properties of two types of chelated aluminum polymers were studied. Monochelated polymers prepared from diisopropoxy or dichloro aluminum monochelates displayed limited hydrolytic and thermal stability. Polymers of trichelated aluminum were prepared and found to be more resistant to hydrolysis. They varied from low-melting, readily organic-soluble thermoplastics to intractable solids stable at $360^\circ C$. Linear polymers were prepared from dichelated titanium diisopropoxides and organic diols. The most stable of these was the product from an 8-quinolinol chelate and 2,2-bis(4-hydroxyphenyl) propane ("Bisphenol-A"), which was inert toward boiling water and when heated to ca. $400^\circ C$. The properties of the chelated aluminum and titanium monomers are given. (Contractor's abstract)

MZH.01:001

Mount Zion Hospital, San Francisco, Calif.

STUDIES OF THE REGIONAL DISTRIBUTION OF BLOOD
FLOW AND BLOOD VOLUME. I. CEPHALIC MEASUREMENTS, by A. E. Lewis. Final rept. Dec. 10, 1957
[12]p. Incl. diags. (AFOSR-TR-58-1) (AF 18(600)1338)
AD 148035 Unclassified

MZH.02:001

A method for measuring blood flow through the cephalic vascular bed was postulated. It was believed that cephalic blood flow could be computed from isotope dilution curves obtained simultaneously over the hand and head following a timed intravenous injection. Certain practical difficulties became obvious when studies were begun on rabbits. Dilution curves on rabbits were too flat even when excessive quantities of isotope were used. Measurement of cardiac output was an essential part of the studies. However, no successful means of measurement was obtained and the methods under consideration were abandoned.

MZH.02:001

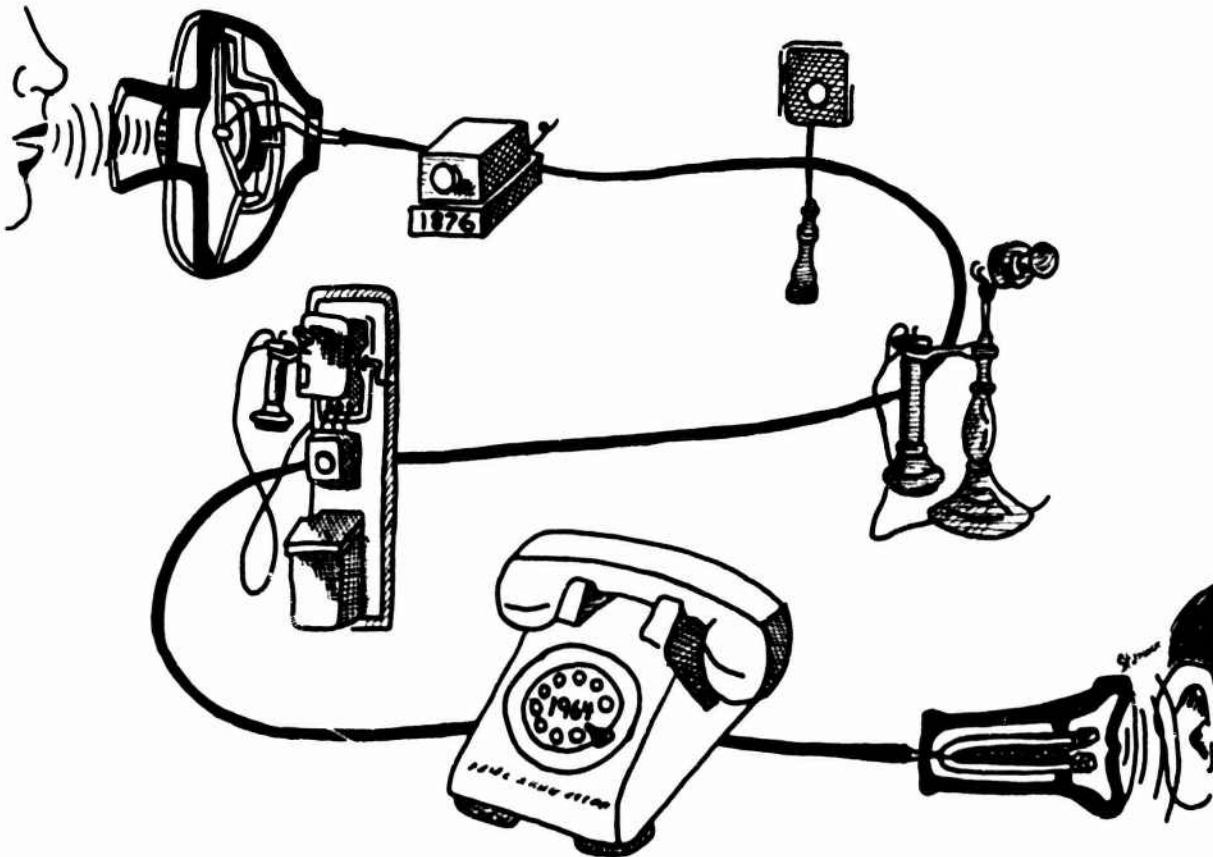
Mount Zion Hospital, San Francisco, Calif.

ON STIMULUS PULSE POLARITY REVERSAL UNIT,

by W. W. Alberts. [1958] [2]p. incl. illus. diagr.
(Bound as Appendix II with its AFOSR-TR-59-58;
AD 218107) (AF 18(603)48) Unclassified

Published in EEG and Clin. Neurophysiol., v. 10: 172-173, Feb. 1958.

A simple means for obtaining a symmetrical waveform (which passes a current pulse first in one direction and then an equal pulse in the other) from a single laboratory stimulator producing unidirectional square pulses is described.



NAT.01:001-003; NAT.02:001

NAT.01:001

National Aeronautical Research Inst., Amsterdam
(Netherlands).

CALCULATION OF AERODYNAMIC FORCES ON SLOWLY OSCILLATING RECTANGULAR WINGS IN SUBSONIC FLOW, by A. I. van de Vorren and E. M. de Jager. Oct. 1, 1956 [69]p. incl. diagrs. tables, refs. (Technical note no. F 192) (AFOSR-TN-57-40) (AF 61-(514)879) AD 115078 Unclassified

A method is presented for the calculation of the aerodynamic forces on a slowly oscillating airfoil. The method is essentially a lifting surface theory which takes into account the unsteady effects due to the wake. Results are given as series containing terms of increasing powers in reduced frequency. The method has been applied to rectangular airfoils. It is shown that if the axis of rotation is ahead of the airfoil, the aerodynamic damping is much less than it would be according to quasi-steady theory. Instability is possible if the aspect ratio is larger than a certain value. This limiting aspect ratio decreases with increasing Mach number.

NAT.01:002

National Aeronautical Research Inst., Amsterdam
(Netherlands).

THE INFLUENCE OF NON-STATIONARY DERIVATIVES ON THE SNAKING MOTION AT HIGH SUBSONIC SPEED, by J. Yff. Nov. 23, 1957 [37]p. incl. diagrs. tables, refs. (Technical rept. no. F 208) (AFOSR-TR-58-20) (AF 61-(514)879) AD 152012 Unclassified

Some lateral stability calculations with two degrees of freedom for flight at high subsonic speed have been performed in order to study the influence of the non-stationary stability derivatives $C_{n\dot{\beta}}$, $C_{y\dot{\beta}}$, $C_{n\dot{r}}$ and $C_{y\dot{r}}$.

on the damping of the snaking motion. These derivatives can be determined theoretically for the case of small aspect ratios and with compressibility taken into account. It is found that only $C_{n\dot{\beta}}$ has a small influence

on the damping in yaw, the influence of the other non-stationary derivatives being negligible. Whether the introduction of $C_{n\dot{\beta}}$ causes a decrease or an increase

of the damping in yaw depends mainly on the aspect ratio of the vertical tail but for nearly all practical tail designs an increase of the damping in yaw will result. Furthermore it is found that the theoretical non-stationary stability derivatives for vertical tails are practically independent of the reduced frequency. (Contractor's abstract)

NAT.01:003

National Aeronautical Research Inst., Amsterdam
(Netherlands).

THE INFLUENCE OF NON-STATIONARY STABILITY DERIVATIVES ON THE LATERAL MOTION AT HIGH SUBSONIC SPEED, by J. Yff. [1958] [13]p. incl. table. (AF 61(514)879) Unclassified

Published in Proc. Third European Aeronautical Congress, Brussels (Belgium) (Sept. 22-27, 1958), Brussels, v. 2: 489-501, 1958.

In view of the uncertainty which exists concerning the influence of unsteady aerodynamic effects upon stability, an investigation has been performed with the purpose of clarifying this question for lateral motions with two degrees of freedom at high subsonic speeds. As the first part of the present investigation, a theory has been developed for the calculation of the aerodynamic forces acting upon a slowly harmonically oscillating finite span airfoil. This theory takes into account also compressibility effects. Moreover, the question has been studied if stability derivatives, which are calculated under the assumption of harmonically varying motions, can be applied to damped motions. Finally some calculations have been made for actual airplanes, in which the importance of the non-stationary stability derivatives has been investigated. It is found that only $C_{n\dot{\beta}}$ has a small influence on the damping in yaw. (Contractor's abstract)

NAT.02:001

National Aeronautical Research Inst., Amsterdam
(Netherlands).

RESEARCH ON THE STATIC AND FATIGUE STRENGTHS OF BONDED AND RIVETED SINGLE LAP JOINTS IN CLAD 2024 AND 7075 ALUMINUM ALLOY AT ROOM AND ELEVATED TEMPERATURES, by A. Hartman and F. A. Jacobs. Sept. 1957 [34]p. incl. illus. diagrs. tables. (Rept. no. M 2041) (AFOSR-TR-57-100) (AF 61(514)938) AD 148033 Unclassified

The report gives the results of an investigation on the effect of an increase of the temperature from 20 to 150°C on the static tensile shear and fatigue properties at fluctuating tension of 2 row riveted and of Hidux 1033 bonded single lap joints of clad 2024-T and clad 7075-T aluminum alloy. The increase of the temperature to 150°C (long soaking times have not been investigated) did not have a noticeable effect on the fatigue properties of the riveted specimens compared to that at room temperature. At 150°C the static strength of light alloy riveted lap joints deteriorates more rapidly than the fatigue properties. The tests on the Hidux bonded specimens showed a noticeable superiority of the bonded clad 2024-T specimens at 150°C over the bonded clad 7075-T specimens, both for the static and the fatigue

NBS.04:004; NBS.29:001;
NBS.06:005; NBS.07:017

properties. The fatigue properties of the Hidux bonded joints decrease gradually at higher temperatures. At 150°C the bonded lap joints showed a better endurance than the riveted specimens at low stress amplitudes with failure in the metal; the opposite occurred at high stress amplitudes. This transition occurred for the bonded clad 2024-T specimens at a higher stress amplitude than for the 7075-T specimens. Posttouring at 150°C did not have a noticeable effect on the mechanical properties of the Hidux bonded joints. (Contractor's abstract)

NBS.04:004

National Bureau of Standards, Washington, D. C.

RELATIVE STRENGTHS OF FORTY AROMATIC CARBOXYLIC ACIDS IN BENZENE AT 25°C, by M. M. Davis and H. E. Hetzer. Sept. 10, 1957 [24]p. incl. diagrs. tables, refs. (NBS Research Paper no. 2871) (AFOSR-TN-57-705) (CSO-670-55-21) AD 132488
Unclassified

Also published in Jour. Res. Nat'l. Bur. Standards, v. 60: 569-592, June 1958.

The relative strengths of benzoic acid, 31 of its mono-substituted derivatives, 7 disubstituted derivatives, and one trisubstituted derivative have been measured in terms of the equilibrium constants (K') for association with the reference base 1,3-diphenylguanidine in benzene at 25°C. The measurements were performed spectrophotometrically, using the indicator acid bromophthalein magna E (tetrabromophenolphthalein ethyl ester) as the reference acid, the equilibrium constant K' for a association of the indicator with diphenylguanidine being known from previous work. Equilibrium constants for p-orseilinic (2,6-dihydroxy-p-toluic) acid and 2,4,6-trinitrobenzoic acid could not be measured, as these acids appear to associate completely with diphenylguanidine under the conditions of the experiments. Plotting $\log K'$ values against the corresponding pK values for aqueous solutions of the acids gives an essentially linear relationship in the case of acids with meta- and para-substituents only, but the line for para-substituted acids has a slightly different slope from the line for m-substituted acids. Similar comparisons were made with published data on relative strengths in alcohols or dioxane-water mixtures. Marked solvent effects were shown by ortho-substituted acids. Explanations of the solvent effects have been suggested, and various theoretical implications and possible applications of the results are discussed. The theoretical discussion includes evaluation of constants of the Hammett equation. (Contractor's abstract)

NBS.29:001

National Bureau of Standards, Washington, D. C.

ELECTROPHORETIC DEPOSITION OF METALS,

METALLOIDS, AND REFRACTORY OXIDES, by V. A. Lamb and W. E. Reid, Jr. Final rept. Apr. 1, 1957, 1v. incl. illus. diagrs. tables, refs. (NBS rept. no. 5216) (AFOSR-TR-57-40) (CSO-670-55-26) AD 132403
Unclassified

A study was made (1) to develop methods for the electrophoretic deposition of refractory metals, metalloids, and oxides and their conversion to practical coatings by heat treatment; and (2) to obtain some insight into the theory and mechanism of electrophoretic deposition through a study of the electrokinetic properties and electrode reactions of these systems. Operating conditions and techniques were developed and defined for electrophoretically depositing a number of metals, metalloids and refractory oxides. Conversion of these deposits to practical coatings by sintering and compaction was shown to be very difficult and requires further development. A coating of Ti-Ni alloy on steel was obtained that may warrant further investigation. The ultramicroscope was used to observe the deposition process in order to obtain information that would add to the knowledge of the mechanism of formation of electrophoretic deposits. The results of several experiments, designed to test proposed theories, tended to favor the accumulation theory, but observations with the ultramicroscope of deposit formation disclosed events that are not in accord with either the accumulation or the ion-flocculation theory.

NBS.06:005

National Bureau of Standards, Washington, D. C.

THEORY OF THE FORBIDDEN TRANSITIONS OF NITROGEN ATOMS TRAPPED IN SOLIDS, by C. M. Herzfeld. [1957] [7]p. incl. diagrs. tables, refs. (AFOSR-TN-57-705) (CSO-680-56-21) AD 138691
Unclassified

Also published in Phys. Rev., v. 107: 1239-1245, Sept. 1, 1957.

A detailed theory of the forbidden transitions of nitrogen atoms trapped in solids is given. The trapped atoms are perturbed by the solid. Configuration interaction, produced by the solid, is important. Splittings and shifts of levels, and reduction of half-lives are explained in one consistent scheme. The trapping sites of atoms are shown to have low symmetry and to be nearly identical for different atoms. (Contractor's abstract)

NBS.07:017

National Bureau of Standards, Washington, D. C.

LUMINOUS REACTION BETWEEN CARBON MONOXIDE AND ATOMIC NITROGEN, by H. P. Broide and D. F. Heath. Jan. 1957 [1]p. (AFOSR-TN-57-24) (CSO-680-56-30) AD 115058
Unclassified

NBS.07:018, 019; NBS.30:001, 002

Also published in Jour. Chem. Phys., v. 26: 1352, May 1957.

The spectra observed for the reaction of atomic nitrogen and CO were predominantly the red ($A^2\Pi - X^2\Sigma^+$) and violet ($B^2\Sigma^+ - X^2\Sigma^+$) CN systems. Also present under some conditions was the first positive system of N_2 with the vibrational distribution typical of the afterglow. When the CO was contaminated with $Fe(CO)_5$, the spectrum of the glow showed intense iron lines. Comparisons are made with the spectra obtained from atomic nitrogen and acetylene.

NBS.07:018

National Bureau of Standards, Washington, D. C.

MOLECULES IN THE SOLAR SPECTRUM, by H. P. Broida and C. E. Moore. [1957] [14]p. incl. tables, refs. [CSO-680-56-30] Unclassified

Published in Mem. Soc. Roy. Sci. Liege, v. 18: 217-230, Aug. 7, 1957.

A general discussion is presented of the molecules identified in the sun by spectroscopic means.

NBS.07:019

National Bureau of Standards, Washington, D. C.

ROTATIONAL LINES OF CH, OH, AND CN IN THE SOLAR SPECTRUM, by C. E. Moore and H. P. Broida. [1957] [12]p. incl. tables, refs. [CSO-680-56-30] Unclassified

Published in Mem. Soc. Roy. Sci. Liege, v. 18: 252-263, Aug. 7, 1957.

A resumé is given of revised identification in the solar spectrum $CH(A^2\Delta - X^2\Pi, B^2\Sigma^- - X^2\Pi, \text{ and } C^2\Sigma^+ - X^2\Pi), OH(A^2\Sigma^+ - X^2\Pi), \text{ and } CN(B^2\Sigma^+ - X^2\Sigma^+).$

NBS.30:001

National Bureau of Standards, Washington, D. C.

SEPARATION OF THE PRODUCTS OF COOL FLAME OXIDATION OF PROPANE, by C. R. Yokley and R. E. Ferguson. July 1957 [24]p. incl. illus. diagrs. tables. (NBS rept. no. 5418) (AFOSR-TN-57-96) (CSO-680-56-33) AD 120445 Unclassified

Also published in Combustion and Flame, v. 2: 117-128, June 1958.

The techniques of gas chromatography and low-temperature, low-pressure distillation were used for the separation and isolation of most of the major products of cool flame oxidation of propane. The products were separated by volatility into 5 fractions, each of which was resolved on one of 3 columns: (1) a charcoal adsorption column for noncondensable gases, (2) a silica gel column for hydrocarbons and CO_2 , and (3) a gas-liquid partition column with bis[2-(2-methoxyethoxy) ethyl] ether as the liquid phase for the separation of oxygenated compounds. The products were identified by a combination of mass spectrometry and gas chromatography. The apparatus included a reaction bulb and manometer, a gas handling system, a low-temperature still, and a gas chromatography line, all of which were constructed as one integral vacuum system. The purity of the smallest samples was in the range of 99.9% as determined by mass spectrometry. Impurities included HCHO and an unidentified compound of molecular weight 104.

NBS.30:002

National Bureau of Standards, Washington, D. C.

THE PRODUCTS OF COOL FLAME OXIDATION OF PROPANE-2- C^{13} , by R. E. Ferguson and C. R. Yokley. Final rept. Apr. 30, 1958, 16p. incl. tables, refs. (NBS rept. no. 5884) (AFOSR-TN-57-97) (CSO-680-56-33) AD 120446 Unclassified

Also published in Seventh Symposium (Internat'l) on Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, p. 113-117.

The major products were isolated by low temperature distillation and gas chromatography; the isotopic composition of each was determined by mass spectrometry. Three separate experiments were conducted with equimolar propane-2- C^{13} /O mixtures. The main products were unreacted propane, propylene, propylene oxide, EtCHO, iso-PrOH, ethane, ethylene, ethylene oxide, AcH, CH_4 , MeOH, HCHO, CO, and CO_2 . Nearly all the Me and methoxy radicals participating in the cool flame reactions came from the end Me groups of propane. AcH was a 2-carbon fragment of the propane, and the C atom in the -CHO group was from the 2-position of the parent molecule. Formaldehyde arose from all 3 atoms of the propane. Most of the CO_2 came from the 2-position in propane. Evidence was obtained for the Me radicals to form ethane and for reactions of Me radicals and CO to give Me_2CO .

NBS. 31:001, 002; NBS. 32:001;
NBS. 33:001

NBS.31:001

National Bureau of Standards, Washington, D. C.

RELATION BETWEEN THE ABSORPTION SPECTRA AND THE CHEMICAL CONSTITUTION OF DYES. XXIX. INTERACTION OF DIRECT AZO DYES IN AQUEOUS SOLUTION, by M. N. Inscoe, J. H. Gould and others. Sept. 1957, 38p. incl. diagrs. tables, refs. (Research paper no. 2823) (AFOSR-TN-57-564) (CSO-680-57-3) AD 206804
Unclassified

Also published in Jour. Res. Nat'l. Bur. Standards, v. 60: 65-83, Jan. 1958.

Interaction of dyes in aqueous solution results in differences in the spectrum of the mixture when compared with the sum of the spectra of the individual dyes. A general survey, chiefly with azo dyes, was made to determine the effect of dye structure on this interaction. The effect of other factors on the interaction of direct azo dyes was investigated. The addition of alcohol or non-ionic detergent prevents this interaction, while the presence of inorganic salts or an increase in dye concentration appears to increase the extent of interaction. The effect of acids and bases is dependent upon the nature of the dyes in the mixture. The results obtained are consistent with the assumption that the forces involved in the interaction of direct azo dyes in mixtures are the same as those causing the aggregation of individual dyes and those binding these dyes to fibers. (Contractor's abstract)

NBS.31:002

National Bureau of Standards, Washington, D. C.

PHOTOCHEMICAL ISOMERIZATION OF AZO DYES IN AQUEOUS SOLUTION, by M. N. Inscoe, J. H. Gould, and W. R. Brode. Sept. 30, 1958 [21]p. incl. diagrs. (NBS rept. no. 6145) (AFOSR-TN-58-782) (CSO-680-57-3) AD 202007
Unclassified

Presented at meeting of the Org. Chem. Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Abstract published in 134th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 95-P.

Several dyes were prepared by the methylation of hydroxyazo dyes, which showed no phototropism in H_2O ,

in order to test the hypothesis that chrysophenine is phototropic in H_2O . The effects of illumination on the spectra of aqueous solutions of the dye derivatives were similar to those for related compounds in nonhydroxylic media. The spectra of a solution of the Na salt of m-(4-methoxyphenylazo)benzenesulfonic acid obtained on illumination with a yellow filter was close to the spectra of the pure trans form. Illumination of the spectra

with a blue filter resulted in an equilibrium mixture containing somewhat more of the cis form. The cis form was relatively stable with a half life of about a week. The absence of fixed isosbestic points in the spectra of chrysophenine indicated that there must be conjugation between the 2 azo groups and therefore 3 inconvertible forms, trans-trans, trans-cis, and cis-cis, exist. In dis-azo dyes prepared from benzidine-2, 2'-disulfonic acid, the sulfonic acid groups prevented coplanarity of the 2 halves of the molecule.

NBS.32:001

National Bureau of Standards, Washington, D. C.

AN ISOTOPIC TRACER STUDY OF CARBON FORMATION IN HYDROCARBON FLAMES, by R. E. Ferguson. Feb. 1957, 15p. incl. tables. (NBS rept. no. 5201; Technical note no. 1) (AFOSR-TN-57-95) (CSO-680-57-12) AD 120444
Unclassified

Also published in Combustion and Flame, v. 1: 431-437, Dec. 1957.

Fuel-rich mixtures of oxygen and propane-2- C^{13} were burned in explosion flames and the isotopic composition of the carbon formed was determined. The results indicated that carbon does not arise from a two-carbon fragment of the propane. Determination of the C^{13} abundance in methane and carbon monoxide in the explosion products indicated that they come equally from the three carbon atoms of the propane. The acetylene recovered contained a nearly random isotope distribution. An investigation of the products of a propane plus $C^{13}O$ /oxygen mixture has provided evidence against the participation of carbon monoxide in carbon formation in typical soot-forming hydrocarbon flames.

NBS.33:001

National Bureau of Standards, Washington, D. C.

SPECTRA OF AFTERGLOWS AND DISCHARGES FROM NITROGEN-OXYGEN MIXTURES, by U. H. Kurzweg, A. M. Bass, and H. P. Broida. May 20, 1957 [17]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-332) (CSO-680-57-15) AD 132406
Unclassified

Also published in Jour. Molecular Spectroscopy, v. 1: 184-200, Oct. 1957.

A systematic investigation has been made of the spectra of the afterglows resulting from electric discharges in mixtures of nitrogen and oxygen. The spectra have been photographed for mixtures ranging from 100% nitrogen to 100% oxygen, pressures from 1 to 5 mm Hg, flow rates from 2 to 20 cm^3/sec , and as a function of time after the discharge. The spectrum range covered is

NBS.33:002 - NBS.33:005

from 3000 to 11,000A, making use of both a prism spectrograph (1/4) and a grating spectrograph (1/0.8). Curves have been prepared to show the relative variations of the individual spectra features as function of the various parameters. (Contractor's abstract)

NBS.33:002

(National Bureau of Standards, Washington, D. C.)

ELECTRONIC QUENCHING OF $\text{OH}(\Sigma^+)$ IN FLAMES AND ITS SIGNIFICANCE IN THE INTERPRETATION OF ROTATIONAL RELAXATION (Abstract), by T. Carrington. July 2, 1957 [1]p. (AFOSR-TN-57-340) [CSO-680-57-15] Unclassified

Presented at Symposium on The Structure and Reactivity of Electronically-Excited Species, Ottawa U. (Canada), Sept. 5-6, 1957.

Experiments on the quenching of fluorescence of OH free radicals in oxy-acetylene flames indicate that almost every collision which an excited OH radical undergoes is effective in removing its electronic energy. Hence, the molecules from which radiation is observed have not been perturbed by any previous collisions, and the rotational intensity distribution in the spectrum is characteristic of the collision process in which the OH radicals were excited. In particular, the molecules whose radiation is observed are not in equilibrium with other energetic molecules in the flames, and their nonthermal distribution does not imply an abnormal persistence of rotation.

NBS.33:003

National Bureau of Standards, Washington, D. C.

SPECTROSCOPIC STUDY OF ELECTRONIC FLAME TEMPERATURES AND ENERGY DISTRIBUTIONS, by H. P. Broida and K. E. Shuler. July 1957 [7]p. incl. diagrs. tables, refs. (AFOSR-TN-57-360) (Sponsored jointly by Air Force Office of Scientific Research under CSO-680-57-15 and Atomic Energy Commission) AD 132433 Unclassified

Presented at Symposium on The Structure and Reactivity of Electronically-Excited Species, Ottawa U. (Canada), Sept. 5-6, 1957.

Also published in Jour. Chem. Phys., v. 27: 933-939, Oct. 1957.

A spectroscopic study has been made of electronic temperatures and electronic excitation in flames from an analysis of the intensity distribution of selected parts of the iron spectrum. The iron was added to the flames in the form of ferrocene to serve as a temperature and excitation "indicator". The flames investigated were the stoichiometric $\text{H}_2 - \text{O}_2$ and $\text{C}_2\text{H}_2 - \text{O}_2$ flames at

atmospheric pressure, a stoichiometric $\text{C}_2\text{H}_2 - \text{O}_2$ flame at low pressure (2.1 mm) and a $\text{N} + \text{CO}$ atomic flame (3.7 mm). This study shows that the iron spectrum can be used as a spectroscopic "thermometer" to determine electronic temperatures in good agreement with adiabatic flame temperatures and OH rotational temperatures in flame regions at thermal equilibrium. The reaction zones of the $\text{C}_2\text{H}_2 - \text{O}_2$ and $\text{N} + \text{CO}$

flames showed a marked departure from equilibrium as indicated by the nonthermal excitation of the added iron, the observed iron spectrum resembling that of an iron arc. This nonthermal excitation of the iron spectrum, which is readily evidenced by the appearance of iron lines originating from high energy levels ($E_n \geq 50,000$

cm^{-1}), can serve as a very sensitive indicator of the departure from equilibrium in a high-temperature reaction system. A brief discussion is given of the possible chemical and energy exchange mechanisms which may give rise to the abnormal excitation of iron in various reaction systems.

NBS.33:004

National Bureau of Standards, Washington, D. C.

ABSORPTION SPECTRA OF SOLIDS CONDENSED AT LOW TEMPERATURES FROM ELECTRIC DISCHARGES, by A. M. Bass and H. P. Broida. Sept. 10, 1957 [12]p. incl. illus. diagrs. table, refs. (AFOSR-TN-57-574) (CSO-680-57-15) AD 136532 Unclassified

Also published in Jour. Molecular Spectroscopy, v. 2: 42-53, Feb. 1958.

Products of electric discharges in gases have been condensed on surfaces cooled by liquid helium. Such films of nitrogen, hydrogen, oxygen, water vapor, and ammonia have been studied by absorption spectroscopy over the spectrum range 0.22 to 3.5 μ . In nitrogen, two very weak absorption bands are observed near 3400A. Hydrogen shows no absorption, but does show a very weak green emission in the gas surrounding the cold surfaces. In oxygen 24 bands are observed in the visible portion of the spectrum, and two in the infrared. Preliminary observations on absorption in water vapor and ammonia are described. In addition, the spectrum has been photographed of the green emission produced by ammonia discharge products condensed on a surface at 77°K. (Contractor's abstract)

NBS.33:005

National Bureau of Standards, Washington, D. C.

WALL EFFECTS ON ROTATIONAL POPULATION OF $\text{OH}(\Sigma^+)$ IN A MICROWAVE DISCHARGE, by T. Carrington and H. P. Broida. Jan. 1958 [31]p. incl.

NBS. 10:002; NBS. 11:004;
NBS. 14:004; NBS. 34:001

diags. table, refs. (AFOSR-TN-58-61) (CSO-680-57-15) AD 148103
Unclassified

Also published in Jour. Molecular Spectroscopy, v. 2: 273-286, June 1958.

A study is presented of the rotational intensity distribution in the $2\Sigma^+ - 2\Pi$ electronic transition of OH radicals excited in electrodeless discharges through argon containing about one-half percent water vapor, at a total pressure of 0.05 mm Hg. Two independent rotational distributions appear, their relative importance depending on the temperature of the wall of the discharge tube, the density of power dissipation in the discharge, and on the frequency of the exciting field. In the sensitivity of the spectrum to changes in discharge conditions, the wall plays a determining role. (Contractor's abstract)

Solutions of the exact linear elastic-shell equations for all stresses and displacements are presented for a typical corrugated-diaphragm shape for three thicknesses varying over a 6 to 1 range. Results were obtained by numerical integration using an electronic digital computer. The effect of thickness-diameter-ratio variation is discussed with respect to both stresses and resultants, and peak values needed for design purposes are presented. Circumferential and meridional stresses are found to be equally important throughout the thickness range analyzed. Bending and membrane stresses are likewise equally important throughout the range. Peak values in some cases occur near the outer rim. (Contractor's abstract)

NBS.14:004

National Bureau of Standards, Washington, D. C.

NBS.10:002

National Bureau of Standards, Washington, D. C.

NUMERICAL EXPERIMENTS IN POTENTIAL THEORY USING THE NEHARI ESTIMATES, by U. W. Hochstrasser. [1957] 12p. incl. diags. tables. (NBS rept. no. 5144) (AFOSR-TN-57-91) [CSO-680-56-50] AD 120439
Unclassified

Also published in Math. Tables Aids Comput., v. 12: 26-33, 1958.

Numerical experiments are undertaken to determine how close Nehari's estimates of the error committed by replacing infinite orthogonal expansions by finite ones in harmonic boundary value problems come to the actual errors in a number of particular examples. The best approximation in each of the seven cases studied gave values which are exact within at most ten percent for many points of the region. The Nehari estimate gives a considerably better bound for the error in the interior of the region than the maximum modulus principle. With respect to the actual error the Nehari estimate is, however, still off by a factor which varied in the examples from 5 to almost 100.

STROBOSCOPIC INTERFEROMETER FOR VIBRATION MEASUREMENT, by E. R. Smith, S. Edelman and others. [1958] [4]p. incl. illus. diags. table, refs. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission and Air Force Office of Scientific Research under [CSO-680-56-20])
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 30: 867-870, Sept. 1958.

This paper describes measurement of vibration amplitude with a Fizeau type interferometer using pulses of monochromatic light of adjustable phase. The interferometer is used to calibrate vibration pickups over the frequency range from 100-20,000 cps. (Contractor's abstract)

NBS.34:001

National Bureau of Standards, Washington, D. C.

USE OF A D.C. AMPLIFIER AND RECORDER TO BALANCE A HIGH PRECISION RESISTANCE BRIDGE, by G. T. Armstrong, P. K. Wong, and L. A. Krieger. Oct. 15, 1957 [26]p. incl. illus. diags. (NBS rept. no. 5683) (AFOSR-TN-57-729) (CSO-680-57-6) AD 136713
Unclassified

Also published in Rev. Scient. Instruments, v. 30: 339-343, May 1959.

By taking corrective action for electrical noise deriving from thermal agitation, alternating current pickup, and induced electrostatic charges, it has been possible to use a commercially available high gain dc amplifier and a recorder to balance a G-3 Mueller Bridge. Noise levels below 0.01 microvolt peak to peak were observed with a response time of approximately five seconds. A precision of approximately two microhms was obtained in measuring a 10 ohm resistor in a short series of measurements. (Contractor's abstract)

NBS.11:004

National Bureau of Standards, Washington, D. C.

BENDING AND STRETCHING OF CORRUGATED DIAPHRAGMS, by R. F. Dressler. [1958] [9]p. incl. diags. (AFOSR-TN-58-164) [CSO-18-600-22] AD 152191
Unclassified

Presented at annual meeting of the Amer. Soc. Mech. Engineers, New York, Nov. 30-Dec. 5, 1958.

Also published in Jour. Basic Engineering, v. 81: 651-659, Dec. 1959.

NBS.35:001 - NBS.35:005

NBS.35:001

[National Bureau of Standards, Washington, D. C.]

THE ELASTIC PROBLEM FOR A RING OF UNIFORM FORCE IN AN INFINITE BODY, by W. H. Pell. [1957] [14]p. incl. diagr. (AFOSR-TN-57-333) [CSO-680-57-16] AD 132407 Unclassified

Also published in Jour. Res. Nat'l. Bur. Standards, v. 60: 365-373, Apr. 1958.

Kelvin has given an integral representation for the displacements in an infinite elastic body produced by a body force acting in an arbitrary portion of this body. By a limit procedure, solutions have been found for point and line singularities acting in the interior of such a body. A similar method is used in this paper to obtain the displacements produced by a uniform force applied along, and normal to, a circle lying in the interior of an infinite elastic body. (Contractor's abstract)

NBS.35:002

National Bureau of Standards, Washington, D. C.

THE TORSION OF A HOLLOW SQUARE, by J. L. Synge and W. F. Cahill. [1957] [6]p. incl. diagrs. tables. (AFOSR-TN-57-744) [CSO-680-57-16] AD 136731 Unclassified

Also published in Quart. Appl. Math., v. 15: 217-224, Oct. 1957.

The Standards Eastern Automatic Computer (SEAC) is used to give an approximate solution to the problem for a hollow square, with accurate determination of lower and upper bounds for torsional rigidity. The hypercircle method developed by Prager and Synge is used. Tabular data of approximations up to the order 48 are included.

NBS.35:003

National Bureau of Standards, Washington, D. C.

UNSTEADY NON-LINEAR WAVES IN SLOPING CHANNELS, by R. F. Dressler. Feb. 5, 1958 [24]p. incl. diagrs. (NBS rept. no. 5768) (AFOSR-TN-58-130) [CSO-680-57-16] AD 152157 Unclassified

Also published in Proc. Royal Soc. (London), v. 247A: 186-198, 1958.

It is shown in general that the exact solution to every non-degenerate unsteady water wave problem in a straight channel inclined at arbitrary slope, governed by the non-linear hydraulic equations, can be obtained in terms of the complete elliptic integral of the second kind, E. By means of a non-Newtonian reference frame, every such wave problem for a sloping channel can be

replaced by an associated problem for a horizontal channel. For the latter, the partial differential equations become reducible and thus permit hodograph inversion. The Riemann integration method for the resulting Euler-Poisson equation yields an auxiliary function for these hydraulic problems which is transformable into a Legendre function and then into the elliptic integral. In particular, the procedure is applied to obtain the exact solution for the water wave in a sloping channel produced by sudden release of the triangular wedge of water (the reservoir) initially at rest behind a vertical wall. The behavior of the solution is exhibited for convenience in two level-line charts, and representative wave profiles and velocity distributions are presented. (Contractor's abstract)

NBS.35:004

National Bureau of Standards, Washington, D. C.

THE STOKES FLOW PROBLEM FOR A CLASS OF AXIALLY SYMMETRIC BODIES, by L. E. Payne and W. H. Pell. Apr. 1, 1959 [35]p. incl. diagrs. tables, refs. (NBS rept. no. 6372) (AFOSR-TN-58-523) [CSO-680-57-16] AD 158336 Unclassified

Also published in Jour. Fluid Mech., v. 7: 529-549, Apr. 1960.

Consideration was given to the solution of the Stokes flow problem for axially symmetric bodies with the aid of the generalized axially symmetric potential theory. After the formulation of the problem and a general discussion of the techniques employed in its solution, discussion is restricted to simply connected regions (in a meridional plane). A general expression for the drag of the simply connected axially symmetric body is obtained, and the Stokes flow problem is solved for the general lens-shaped body. Some interesting special cases of this body are discussed. As examples of the method, some previously solved problems are discussed briefly. Finally, a table of the drag of various bodies in Stokes flow is given. (Contractor's abstract)

NBS.35:005

National Bureau of Standards, Washington, D. C.

THE STOKES FLOW PROBLEM FOR CLASS OF AXIALLY SYMMETRIC BODIES. II. THE FLOW ABOUT A SPINDLE, by W. H. Pell and L. E. Payne. July 31, 1959 [10]p. incl. diagr. (NBS rept. no. 6474) (AFOSR-TN-58-523a) [CSO-680-57-16] AD 220570 Unclassified

Also published in Quart. Appl. Math., v. 18: 257-262, 1960/61.

The solutions of the system are shown by the use of the solution of the repeated operator equation

NBS.35:006, 007; NBS.18:017

$L_{-1}^2 \psi_1 = 0$ subject to initial conditions and where ψ_1 (a second stream function) is given by $\psi = \frac{1}{2} U r^2 - \psi_{-1}$. In certain regions, a solution can be represented as a linear combination of any two functions: (1) $r^{2,3}$, (2) $x r^{2,3}$, (3) $\rho^2 r^{2,3}$, (4) $r^{2,1}$, and (5) $r^{4,5}$. Bipolar coordinates (ξ, η) are introduced into the (x, r) plane by the transformation $z = i b \cot \xi / 2$ where $z = x + i r$, $\xi = \xi + i \eta$, and $b > 0$ is a constant. The flow is then studied around a spindle which is the object obtained by revolving the arc $\xi = \xi_0$ ($0 < \xi_0 < \pi$), $r \geq 0$ about the x -axis. The curve is the circle arc with center at $(0, -b \cot \xi_0)$ and lies in $r \geq 0$. The spindle surface is $\xi = \xi_0$ and the region of flow studied is $0 \leq \xi \leq \xi_0$, $-\infty < \eta < \infty$ with ξ and η chosen as independent variables.

NBS.35:006

National Bureau of Standards, Washington, D. C.

COMPRESSIBLE TURBULENT BOUNDARY LAYERS WITH HEAT TRANSFER AND PRESSURE GRADIENT IN FLOW DIRECTION, by A. Walz. [July 1958] [32]p. incl. diagrs. refs. (NBS rept. no. 6223) (AFOSR-TN-58-635) [CSO-680-57-16] AD 162166 Unclassified

Also published in Jour. Res. Nat'l. Bur. Standards, v. 63B: 53-70, July-Sept. 1959.

The empirical laws for dissipation and for turbulent wall friction are formulated on the basis of available measurements for incompressible flow. Generalization to the compressible flow with heat transfer is made from physical considerations. Calculated results agree with available experimental data. Possibilities for improving and simplifying the approximation theory are outlined.

NBS.35:007

National Bureau of Standards, Washington, D. C.

KINETIC EQUATION FOR A PLASMA WITH UNSTEADY CORRELATIONS, by C. M. Tchen. Jan. 1, 1959, 56p. (NBS rept. no. 6274) (AFOSR-TN-58-636) [CSO-680-57-16] AD 162167 Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

Also published in Phys. Rev., v. 114: 394-411, Apr. 15, 1959.

As a generalization of the Boltzmann equation, the kinetic equation for a plasma is derived in the form of a generalized Fokker-Planck equation, by considering unsteady

correlations, including non-Markovian and nonlinear behavior. Both the binary and ternary correlations are used for many kinds of particles with different temperatures. The coefficients of the kinetic equation depend on the law of interaction for a pair of particles and are influenced by relaxation. The effective potential of friction consists of two parts: the static part corresponds to the Debye potential and is isotropic, the dynamical part is axially symmetrical about the direction of motion, and causes a dynamical friction. The results show that the friction is proportional to the velocity for slow particles, and inversely proportional to the square of velocity for fast particles. This tendency of the fast particles to overcome repulsion is a property connected with the "run-away" of electrons. A criterion for maximum friction is derived. The triplet interaction, which mainly affects the shielding phenomena, assures the convergence of the coefficients in case of distant interaction. Since the length scales of interaction are well determined in this way, the kinetic equation can be expected to be valid over a longer range than does the Boltzmann equation. The large scale agrees with the Debye radius, when the shielding term is linearized, as should be expected. When time relaxation is left aside and linearization is made, the kinetic equation degenerates to the classical Fokker-Planck equation with convergent coefficients. (Contractor's abstract)

NBS.18:017

National Bureau of Standards, Washington, D. C.

SHAPE OF THE HIGH ENERGY END OF THE ELECTRON-BREMSSTRAHLUNG SPECTRUM, by E. G. Fuller, E. Hayward, and H. W. Koch. Aug. 1957 [19]p. incl. diagrs. tables, refs. (AFOSR-TN-57-679) [CSO-680-57-2] Unclassified

Also published in Phys. Rev., v. 109: 630-635, Feb. 1, 1958.

The elastic scattering of photons by the 15.11 mev level in C^{12} has been used to study with good energy resolution the number of photons at the high-energy end of a bremsstrahlung spectrum. The bremsstrahlung was produced by electrons accelerated in a betatron, the energy of which was varied in 35-kev increments. Targets were a 0.025-in.-diameter tungsten wire and the following foils: 0.010-in. tungsten, 0.001-in. thorium and 0.010-in. nickel. The foils were used to study the dependence of the spectrum shape upon target thickness and atomic number. When compared with Bethe-Heitler spectra corrected for target thicknesses, the data indicate an excess number of photons in the tip of the spectrum. The experimental number depends on the atomic number of the target and cannot vary more rapidly than Z^2 . (Contractor's abstract)

NBS.18:018; NBS.36:001-003

NBS.18:018

National Bureau of Standards, Washington, D. C.

MASS-ABSORPTION COEFFICIENTS FOR 40- TO 80-MEV X-RAYS IN CARBON, WATER, AND ALUMINUM (Abstract), by J. M. Wyckoff and H. W. Koch. [1958] [1]p. [CSO-680-57-2] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 174, May 1, 1958.

A good geometry measurement has been made of 90-mev synchrotron x-ray spectra transmitted through long cylinders of carbon, water, and aluminum. A "hydrogen" measurement was made using a cyclohexane-benzene difference method. The x-ray detector system was a 5-in. diam by 9-in. long NaI (Tl) spectrometer and a 256 channel pulse-height analyzer. The pulse-height distributions clearly show the nuclear absorption below 40 mev. The distributions also permit an accurate evaluation of the total absorption processes in the energy range from 40 to 80 mev. The carbon measurement at 60 mev gives $\tau = 0.01434 \pm 0.00005 \text{ cm}^2/\text{g}$ which is 1% and 5% higher respectively than the published values. The values measured for water and aluminum at 60 mev of 0.0170 and 0.0239 cm^2/g are also higher. For hydrogen at 60 mev $\tau = 0.0128$, a value between those in the two tables. The differences are largely accounted for by the triplet cross section estimates of Joseph and Rohrllich.

NBS.36:001

National Bureau of Standards, Washington, D. C.

ELASTIC SCATTERING OF PHOTONS, by E. G. Fuller and E. Hayward. Final rept. Jan. 1, 1959, 1v. incl. illus. diagrs. tables, refs. (NBS rept. no. 6255) (AFOSR-TR-58-162) (CSO-680-58-16) AD 207250 Unclassified

The work of the project is summarized and the principal publications emanating from the research are appended. Betatron x-rays were used to measure the elastic scattering cross sections for a number of elements in the energy range 4-40 mev. The results indicated that in regions where the scattering cross section is flat with photon energy the experimental points should be plotted at $.94E_0$, where E_0 is the maximum energy in the bremsstrahlung spectrum. Where the cross section is either rising or falling rapidly the points should be plotted at $.93E_0$. In all cases the measured cross sections are averages over a photon bin approximately $0.1 E_0$ wide.

No matter what the shape of the scattering cross section, inelastic scattering can only be measured to levels within

$0.15 E_0$ of the ground state. For a sharply rising cross section only levels within $0.10 E_0$ should be considered.

The scattering cross sections calculated in this experiment are sensitive to the choice of end point channel. These errors will be of the order of 5-10% providing the end point channel is chosen high enough in the pulse height spectrum.

NBS.36:002

National Bureau of Standards, Washington, D. C.

THE NUCLEAR PHOTOEFFECT AND NUCLEAR DEFORMATIONS, by E. G. Fuller. [1958] [4]p. incl. diagrs. table. [CSO-680-58-16] Unclassified

Published in Internat'l. Congress on Nuclear Phys., Paris (France) (July 7-12, 1958), Paris, Dunod, 1959, p. 642-645.

The correlation of the shape of the giant resonance for photon absorption with the ground state nuclear deformation as predicted by Okamoto and Danos has been studied by a "poor energy resolution" survey of the shape of the neutron production cross section for nuclei ranging from tin through the rare earths to lead and by a "good energy resolution" determination of the shape of this cross section for terbium, tantalum and gold. After correction for the neutron multiplicity above the $(\gamma, 2n)$ threshold the data indicate a considerable broadening of the giant resonance for the highly deformed nuclei. The "good energy resolution" data show a splitting of the giant resonance for the deformed nuclei terbium and tantalum into two peaks while only one such peak is observed for gold. These data can be well fitted by the superposition of two Lorentz lines. The intrinsic quadrupole moments determined from these fits were: Tb: $+5.6 \pm 0.6$ barns, Ta: $+5.7 \pm 0.3$ barns, and Au: $+1.6 \pm 0.6$ barns. Preliminary measurements of the elastic scattering cross section for tantalum also show the splitting of the total absorption cross section into two peaks. (Contractor's abstract)

NBS.36:003

National Bureau of Standards, Washington, D. C.

PHOTON SCATTERING AND SELF ABSORPTION IN LEAD AND BISMUTH AT 7 MEV, by E. G. Fuller and E. Hayward. [1958] 4p. incl. tables. (Bound with its AFOSR-TR-58-162; AD 207250) [CSO-680-58-16] Unclassified

Also published in Internat'l. Congress on Nuclear Phys., Paris (France) (July 7-12, 1958), Paris, Dunod, 1959, p. 646-648.

Elastic scattering cross sections for lead, tantalum, and bismuth have been measured in the energy range

NBS.36:004; NBS.20:004, 005;
NBS.21:020

from 4 to 10 mev. Self-absorption measurements have been made at photon energies below the (γ, n) thresholds. These measurements, made both at room temperature and at liquid nitrogen temperature, indicate that the levels responsible for the scattering in radiolead have widths between 0.2 and 3.0 ev while those in lead and bismuth must be greater than 3.0 ev wide. Evidence has also been obtained that a large fraction of the scattering by bismuth is produced by a single strong level which overlaps a similar level in ^{208}Pb . (Contractor's abstract)

NBS.36:004

National Bureau of Standards, Washington, D. C.

ELASTIC SCATTERING OF PHOTONS BY TANTALUM, by E. G. Fuller and E. Hayward. [1958] [3p. [CSO-680-58-16] Unclassified

Published in Phys. Rev. Letters, v. 1: 465-467, Dec. 15, 1958.

The differential elastic scattering cross-section for tantalum, at 120° , is measured and analyzed as a function of the energy. It is found that the assumption that the nuclear dipole polarizability is a tensor gives a better fit than taking the polarizability as a scalar.

NBS.20:004

National Bureau of Standards, Washington, D. C.

PHOTON SELF-ABSORPTION AND SCATTERING BY THE 15.1-MEV LEVEL IN C^{12} , by E. Hayward and E. G. Fuller. [1957] [5p. incl. diagrs. tables, refs. (AFOSR-TN-57-559) (CSO-630-55-35) AD 136543 Unclassified

Also published in Phys. Rev., v. 106: 991-995, June 1, 1957.

Bremsstrahlung x-rays have been used to excite the 15.1-mev level in C^{12} . The integral scattering cross section of 19.0 ± 0.027 mev mb has been determined by measuring the absolute number by 15.1-mev x-rays scattered. The peak absorption cross section 22.2 ± 2.2 barns has been obtained from a self-absorption experiment. These results combine to give 54.5 ± 9.3 ev for the ground state radiation width and 79 ± 16 ev for the total width of the level. (Contractor's abstract)

NBS.20:005

[National Bureau of Standards, Washington, D. C.]

A SCINTILLATION SPECTROMETER STUDY OF THE PHOTODISINTEGRATION OF O^{16} , by N. L. Svantesson.

[1957] [26p. incl. illus. diagrs. tables, refs. [CSO-630-55-35] Unclassified

Published in Nuclear Phys., v. 3: 273-298, Apr. 1957.

The nuclear reactions $\text{O}^{16}(\gamma, p\gamma')\text{N}^{15}$ and $\text{O}^{16}(\gamma, n\gamma')\text{O}^{15}$ were used to study the photodisintegration of O^{16} . Various bremsstrahlung spectra with peak energies ranging between 16 and 30 mev were used to excite the target nuclei. The photons emitted in the two reactions were measured with a NaI(Tl) scintillation spectrometer covering photon energies from 2 to 11 mev. The results support the belief of the 6.1 and 6.3 mev states in O^{15} and N^{15} , respectively, being $p_{3/2}^{-1}$ states. Transitions to these two states, 30 percent, are together with ground state transitions, 70 percent, the only ones observed between 20.0-22.5 mev excitation energies. In the regions between 22.5 and 25.0 mev also transitions to 7, 9, and 10-11 mev states were observed. Ground state transitions in this interval occurred in about 40 percent, while the transition probability to excited states was shared roughly equally between the 6.1-6.3 mev states and all the other states, mainly the 7 mev states. σ_{int} from 20-25 mev amounted to about 0.1 mev · barn. The ratio between σ_{int} for (γ, p) and (γ, n) reactions was about 3:2. The nuclear elastic scattering of photons was also measured and was used to determine the integrated cross section for photon absorption up to 40 mev which was found to be 0.3 mev · barn. (Contractor's abstract)

NBS.21:020

National Bureau of Standards, Washington, D. C.

A PRELIMINARY SURVEY OF ELECTRICAL RESISTANCE-STRAIN CHARACTERISTICS OF EVAPORATED FILMS, by A. Krinsky and R. L. Parker. Feb. 1957, 42p. incl. illus. diagrs. tables, refs. (NBS rept. no. 5139) (Sponsored jointly by Office of Naval Research under NAord 21-48, Air Force Office of Scientific Research under CSO-640-55-9, and Atomic Energy Commission) AD 130128 Unclassified

A preliminary investigation of the electrical-resistance-strain characteristics of evaporated films has been undertaken. A total of 22 materials (Pt, Pd, Sb, Co, Au, Ni, Te, Al, Fe, Cu, Cr, Ag, Sn, Ge, Mg, Mn, Ti, Se, V, Be, Nichrome, Kanthal 'A') has been studied. Methods of preparation and test are described. Results for tests performed at room temperature on about 300 samples are presented and discussed. In general, strain-sensitivity is found to be a function of film specific resistance. For films of specific resistance 1-10 ohms/square, for the strain-sensitivity approaches the bulk value. For higher specific resistance films, the strain-sensitivity decreases to reach a minimum value. For films of even higher specific resistance (up to 10^6 - 10^7 ohms/square) the strain-sensitivity increases

NBS. 21:021-024; NBS. 24:003

to a value several times greater than the bulk value. Film thicknesses range from about 50 A.U. to 1000 A.U. Certain effects peculiar to Sb and Ni films are mentioned. (Contractor's abstract)

NBS. 21:021

National Bureau of Standards, Washington, D. C.

MEASUREMENT OF VOLTAGE RATIOS AT AUDIO FREQUENCIES, by W. C. Sze. Mar. 1957 [37]p. incl. illus. diagrs. tables. (NBS rept. no. 5173) (Sponsored jointly by Office of Naval Research under NAord 21-48, Air Force Office of Scientific Research under CSO-640-55-9, and Atomic Energy Commission) AD 128790 Unclassified

A special circuit and procedure has been given to determine the voltage ratio and phase angle of precision transformers in the frequency range from 400 to 10,000 cps. The voltage ratio can be measured to 0.005% accuracy and the phase angle to 0.2 min by use of the symmetrically arranged circuit.

NBS. 21:022

National Bureau of Standards, Washington, D. C.

METHODS OF MEASURING FREE AIR TEMPERATURE AND AIRCRAFT TRUE AIRSPEED AND GROUND SPEED, by W. G. Brombacher. Jan. 1958, 226p. incl. tables, refs. (NBS rept. no. 5740) (Sponsored jointly by Office of Naval Research, [Air Force Office of Scientific Research], and Atomic Energy Commission under [CSO-640-55-9]) Unclassified

This survey covers in some detail (a) the methods and instrumentation for measuring the free air temperature from moving aircraft, (b) the pitot-static method of measuring the true airspeed of aircraft, and (c) the methods of measuring ground speed solely from aircraft instrumentation. Less thoroughly covered are (d) the possible methods, other than pitot-static, of measuring true airspeed and (e) the ground based methods of measuring aircraft track and position, hence speed indirectly. Over 900 references to pertinent literature are included, which have been indexed both by subject matter and authors. (Contractor's abstract)

NBS. 21:023

National Bureau of Standards, Washington, D. C.

IMPROVED VELOCITY ANALYZER, by J. A. Simpson. Apr. 1958, 30p. incl. illus. diagrs. tables, refs. (NBS rept. no. 5816) (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Atomic Energy Commission under [CSO-640-55-9]) AD 159712 Unclassified

An extensive search is to be completed of the literature supplemented by such additional computation as may appear desirable in order to arrive at a full understanding of the fundamental limits of proposed and existing instruments. Upon the basis of this work, the type of types offering the most promise of fulfilling the design criteria are decided. Calculations are carried out in as much detail as possible, of the expected performance of the chosen design. The calculations may be supplemented by such small scale laboratory tests and experiments as shall be essential to complete the study. A simple analyzer of the type chosen was designed and built, its characteristics determined by test, and compared to those calculated. Upon the successful outcome of these tests, the mechanical design of an electron spectrometer (with auxiliary power supplies, etc.) is to be completed and construction and test of the prototype undertaken. (Contractor's abstract)

NBS. 21:024

National Bureau of Standards, Washington, D. C.

ELECTRON ABSORPTION SPECTROMETER USING AN IMPROVED VELOCITY ANALYZER, by L. Marton and J. A. Simpson. [1958] [4]p. incl. illus. diagrs. refs. (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Atomic Energy Commission under [CSO-640-55-9]) Unclassified

Published in Rev. Scient. Instruments, v. 29: 567-570, July 1958.

An electron absorption spectrometer with an improved velocity analyzer using the principle of individually designed stages for deceleration, dispersion, and reacceleration is described. The instrument is usable over an energy range 1 to 50 kev and can obtain angular distribution data over a range of ± 0.1 radian. The angular resolution is better than 10^{-3} radian. The demonstrated energy resolution at 20 kev is 0.6 ev. This resolution appears to be limited by the primary beam energy spread which is characteristic of a beam produced by a telefocus gun with a tungsten cathode. (Contractor's abstract)

NBS. 24:003

National Bureau of Standards, Washington, D. C.

THE PIEZORESISTANCE OF INDIUM ANTIMONIDE, by R. F. Potter. May 20, 1957 [30]p. incl. diagrs. tables, refs. (NBS rept. no. 5292) [AFOSR-TR-57-42] (CSO-670-53-12) AD 132446 Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 121, Mar. 21, 1957.

NBS. 24:004, 005; NBS. 25:026, 027

Also published in Phys. Rev., v. 108: 652-658, Nov. 1, 1957.

By applying a tensile stress to specially prepared and oriented samples, the piezoresistivity coefficients of both n- and p-type indium antimonide have been measured over the temperature range 77°K to 300°K. The results for extrinsic p-type material are similar to those for p-type Si and Ge, indicating that the valence band structure is similar. Extrinsic n-type InSb results confirm the picture of a conduction band having its minimum at the center of the Brillouin zone. The largest effect that was observed in intrinsic material was in the volume coefficient and can be attributed to the change in the forbidden gap due to dilatation of the lattice. The value of this gap per unit strain was estimated to be $E_{lg} = -7.0$ ev. (Contractor's abstract)

NBS.24:004

National Bureau of Standards, Washington, D. C.

AN APPARATUS FOR MEASURING THE PIEZORESISTIVITY OF SEMICONDUCTORS, by R. F. Potter and W. J. McKean. Technical rept. June 1, 1957 [20]p. incl. illus. diags. (NBS rept. no. 5293) [AFOSR-TR-57-43] (CSO-670-53-12) AD 132447 Unclassified

A detailed description is given of an apparatus and procedure that is designed to measure the piezoresistive effect in semiconductors over an extended temperature range. A tensile force up to 1 kg can be applied to the sample by means of a calibrated beam balance. The apparatus has been used for measurements on InSb over the temperature range 78°K - 300°K and tensile stresses of the order of 5×10^7 dynes/cm² can be applied to the samples which are cut in a special manner. (Contractor's abstract)

NBS.24:005

National Bureau of Standards, Washington, D. C.

THE IONIC CHARACTER AND ELASTIC MODULI OF ZINC BLENDE LATTICES, by R. F. Potter. [1957] [6]p. incl. diagr. tables, refs. (CSO-670-53-12) Unclassified

Published in Jour. Phys. Chem. Solids, v. 3: 223-228, 1957.

The elastic moduli for a number of materials with the diamond or zinc blende (sphalerite) crystal structure are available in the literature. It has been noticed that the ratio C_{11}/C_{12} has values between 2.6 and 2.7 for Si and Ge, respectively, and 1.65 or 1.50 in the case of ZnS. InSb and GaSb have elastic moduli that give intermediate values for this ratio. A scale which gives the

ionic character as a function of the ratio C_{11}/C_{12} has been constructed based on the Born diamond lattice theory and the relationship between the longitudinal optical mode and transverse optical modes when the lattice has some ionic character. This scale indicates that InSb has the ionic character that corresponds to an ionic charge of 0.65 electron. GaSb has an ionic character approximately two-thirds of that for InSb. Conversely, the elastic moduli may be estimated for crystals of this type if the optical data are available. (Contractor's abstract)

NBS.25:026

National Bureau of Standards, Washington, D. C.

CALORIMETRIC DETERMINATION OF THE POWER IN A 1400 kv X-RAY BEAM, by J. McElhinney, B. Zendle, and S. R. Domen. [1957] [15]p. incl. illus. diags. tables, refs. (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Atomic Energy Commission under [CSO-670-54-7]) Unclassified

Published in Radiation Research, v. 6: 40-54, Jan. 1957.

The power in a 1400-kv x-ray beam has been measured with a calorimeter and the results compared with simultaneous measurements made by a graphite-walled ionization chamber. The experimental conversion factor was found to be 2983 ± 69 ergs/cm² per roentgen as compared with a theoretical value of 2985 ergs/cm² per roentgen. (Contractor's abstract)

NBS.25:027

National Bureau of Standards, Washington, D. C.

THE MEASUREMENT OF THICKNESS, by G. Keimath. Jan. 20, 1958, 79p. incl. illus. diags. tables, refs. (NBS circular no. 585) (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Atomic Energy Commission under [CSO-670-54-7]) Unclassified

The numerous methods for the measurement of thickness in laboratory or shop are treated in seven groups according to physical operating principles: mechanical - weight/dimension relationships, acoustics, vibration, displacement with various conversions; chemical - stripping, spectrochemical analysis; electrical - dielectric breakdown, resistance, electrochemical, capacitance, thermoelectricity; magnetic - attractive force, reluctance, saturation, inductance, eddy currents; optical - microscopy (also electron microscopy), interferometry, diffraction, shadow; X-ray - absorption, diffraction, backscatter, spectrometry; radioactive radiation - absorption, backscatter, tracers. Ranges, accuracies, advantages,

NBS. 25:028; NBS. 26:004;
NBS. 37:001, 002; NBS. 27:002

and limitations are discussed. A bibliography of references, a limited list of suppliers, and a detailed index of the gages, methods, applications, and trade names covered are appended. (Contractor's abstract)

NBS.25:028

National Bureau of Standards, Washington, D. C.

ACCESSIBILITY OF RUSSIAN SCIENTIFIC AND TECHNICAL LITERATURE IN WESTERN NATIONS, tr. by J. F. Smith. Aug. 1958, 12p. incl. refs. (NBS rept. no. 6115) (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research under [CSO-670-54-7], and Atomic Energy Commission) AD 203624
Unclassified

Brief discussion is devoted to Russian publication and dissemination operations. Russian national bibliographies are listed. Their abstracting services are cited. Western accessibility to Russian literature is outlined. The translation problem is discussed. A bibliography of twenty-four references is included.

NBS.26:004

National Bureau of Standards, Washington, D. C.

A FIELD EMITTER POINT PROJECTION X-RAY MICROSCOPE, by L. Marton, R. A. Schrack, and R. B. Placous. [1957] [6]p. incl. illus. diagrs. [CSO-680-58-19]
Unclassified

Published in Proc. First Internat'l. Symposium on X-ray Microscopy and Microradiography, Cavendish Lab., Cambridge (Gt. Brit.) (Aug. 16-21, 1958), New York Academic Press, 1957, p. 287-292.

A demountable glass and brass field emission x-ray microscope has been constructed which has higher current densities and smaller image size than thermionic devices and thus correspondingly higher resolutions for given exposure times. A resolution of 0.5μ has been obtained and the expected electron spot size of 0.2μ has practically been realized.

NBS.37:001

National Bureau of Standards, Washington, D. C.

STATISTICAL MECHANICS AND THE BOLTZMANN EQUATION, by M. S. Green. [1958] [7]p. (AFOSR-TN-56-556) [CSO-880-58-24]
Unclassified

Also published in Proc. Internat'l. Symposium on Transport Processes in Statistical Mechanics, Brussels (Belgium) (Aug. 27-31, 1956), N. Y. Interscience Publishers, Inc., 1958, p. 8-14.

It was determined that although the equations for the distribution functions have many solutions corresponding to arbitrary specifications of the initial values of all the distribution functions, the memory of these initial conditions are lost except for widely separated points which are of no significance for most properties of the system. The time for initial correlations to be scattered in such a harmless way depends on the magnitude of the initial regions of correlations. While this time may be large for some initial conditions, it may be expected that it is usually of the order of magnitude of the duration of a collision. (Contractor's abstract)

NBS.37:002

National Bureau of Standards, Washington, D. C.

THE INTRINSIC BULK VISCOSITY IN MONATOMIC AND DIATOMIC GASES, by R. E. Nettleton. [June 1957] 35p. incl. refs. (AFOSR-TN-57-321) (CSO-680-56-24)
AD 132392
Unclassified

Also published in Jour. Appl. Phys., v. 29: 204-212, Feb. 1958.

The Born-Green Theory, employing the Kirkwood superposition approximation, is investigated as a means of calculating the intrinsic bulk viscosity - a bulk viscosity due solely to Van der Waals interactions - in a monatomic gas. It is found that the Kirkwood approximation lacks a principle of irreversibility, so that homogeneous integral equations are obtained with no normalizing conditions. By the neglect of terms of the order of contributions from triple collisions, expressions for the bulk viscosity are derived in terms of other thermodynamic quantities which yield rough values of the order of one micropoise for argon and nitrogen at 0°C , 1 atmos. (Contractor's abstract)

NBS.27:002

National Bureau of Standards, Washington, D. C.

MICROWAVE ABSORPTION OF GASES, by C. T. Zahn. Final technical rept. Dec. 31, 1957, 1v. incl. diagrs. (NBS rept. no. 5673) (AFOSR-TR-57-94) (CSO-880-57-9) AD 136740
Unclassified

A high-Q resonant-cavity method has been developed for the measurement of very small microwave absorption coefficients. The present status of theoretical and experimental knowledge in the field of microwave absorption and pressure broadening of spectral lines is discussed. For some obscure reasons it was found to be extremely difficult to obtain stable conditions in experimental tests of the method. The observed behavior was such as to suggest that unexpected, and as yet unexplained, surface phenomena were operative. In the limited time available it was not possible either to determine the exact nature of these effects or to exploit the

NBS. 38:001, 002; NBS. 39:001;
NBS. 40:001

full possibilities of the method, although it shows great promise for further refinement. Measurements were made of the absorption coefficient of pure water-vapor very near the resonance frequency of the 22,237 mc spectral line. These results are compared with those of previous investigators, and it is suggested that the considerable discrepancies between theory and experiment, previously pointed out by Van Vleck, may be due to spurious surface effects. (Contractor's abstract)

NBS.38:001

National Bureau of Standards [Boulder, Colo.]

PERFORMANCE OF THREE-MILLIMETER HARMONIC GENERATORS AND CRYSTAL DETECTORS, by J. M. Richardson and R. B. Riley. [1957] [5]p. incl. diagrs. tables. (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Atomic Energy Commission under [CSO-680-57-11])

Unclassified

Published in I.R.E. Trans. of Professional Group on Microwave Theory and Techniques, v. MTT-5: 131-135, Apr. 1957.

Because of growing applications of millimeter wave measurements, a fairly thorough investigation of what could be expected from sources and detectors in the 3 mm region was made. The sources consisted of fourth-harmonic generators from a 1.25 cm fundamental. A type of crystal holder for both harmonic generators and detectors in which a small crystal wafer is positioned in the broad wall of the millimeter waveguide, being contacted by a whisker passing across the waveguide (the open-guide type) was found to be superior in general to units using crystal cartridges or modifications thereof. Factors affecting the performance of these units have been investigated statistically. It was found that the short-circuit current sensitivity in microamperes per microwatt of a good crystal detector of the type described above is not greatly less than the value for crystals at lower microwave frequencies, so that the minimum detectable signal is about the same. As an additional result, evidence for an important effect in which harmonic generation process degrades the signal-to-noise ratio of the source is presented and discussed. (Contractor's abstract)

NBS.38:002

National Bureau of Standards [Boulder, Colo.]

EXCESS NOISE IN MICROWAVE CRYSTAL DIODES USED AS RECTIFIERS AND HARMONIC GENERATORS, by J. M. Richardson and J. J. Farris. [1957] [5]p. incl. diagrs. table. (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Atomic Energy Commission under [CSO-680-57-11])

Unclassified

Published in I.R.E. Trans. on Microwave Theory and Techniques, v. MTT-5: 208-212, July 1957.

Excess noise produced by microwave excitation of silicon crystal diodes was studied for operation of the crystal as a detector and as a microwave harmonic generator. The noise appears at the detector terminals and also as noise sidebands off the microwave harmonic, thus degrading the spectral purity of the harmonic relative to that of the fundamental. Possible models of the processes involved are presented. Difficulties and technique of measurement are discussed. Observations for 1N26 crystals, used as detectors, doublers, and triplers, and excited by X-band power in the range 8 to 100 mw are presented, showing limitations on spectral purity set by the process of noise production during harmonic generation. (Contractor's abstract)

NBS.39:001

National Bureau of Standards, Washington, D. C.

PIEZOELECTRIC EFFECT IN INDIUM ANTIMONIDE, by J. H. Wasilik and R. B. Flippen. [1958] [2]p. incl. table. (CSO-680-59-6) Unclassified

Published in Phys. Rev. Letters, v. 1: 233-234, Oct. 1, 1958.

Piezoelectric resonance has been observed in a pair of InSb crystals at low temperatures. A p-type crystal and a crystal having a p-n junction have been cut normal to the 111 direction and a variable harmonic disturbance imposed. The observed resonances approached the values calculated for the plates of crystals. The contact impedance between the leads and the sample made an estimate of the constant d_{12} impossible.

NBS.40:001

National Bureau of Standards, Washington, D. C.

LIFETIMES AND SPECTRAL DEPENDENCE OF THE PHOTOCONDUCTIVITY AND PHOTOELECTROMAGNETIC EFFECTS IN MAGNESIUM STANNIDE, by J. H. Becker and I. I. Sochard. Sept. 1, 1957, 43p. incl. diagrs. tables, refs. (NBS rept. no. 5484) (AFOSR-TR-57-59) (CSO-680-56-39) AD 136527 Unclassified

Lifetimes of optically created electron-hole pairs have been evaluated from the short wavelength limit of the photoconductance and PEM short-circuit current. Investigations were carried out for n- and p-type crystals of Mg_2Sn over the temperature range 400°K to 78°K. At room temperature the lifetimes for all samples were in the range 0.12 to 0.17 μ sec. At high temperatures $\tau \sim \exp E_g(0^\circ K)/2kT$ applied. Possible interpretations in terms of direct recombination (radiative) or

NBS. 40:002, 003; NBS. 41:001

recombination through centers are discussed. The spectral dependence of the photoconductance and PEM short-circuit current was investigated for wavelengths between 0.5μ and 5.5μ . Theoretical expressions which apply for thick samples are presented. The experimental results are adequately described by theory. Surface recombination velocities and absorption coefficients were evaluated from the spectral dependence studies. Absorption due to indirect transitions can account for the energy dependence of the absorption coefficient which was observed (146°K). The forbidden energy gap calculated from the threshold frequency is in agreement with values which have been reported for the thermal band gap. (Contractor's abstract)

NBS.40:002

National Bureau of Standards, Washington, D. C.

MAGNETIC FIELD DEPENDENCE OF THE HALL COEFFICIENT AND ELECTRICAL CONDUCTIVITY IN SEMICONDUCTORS (Abstract), by J. H. Becker. [1957] [1]p. [CSO-680-56-39] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 57, Jan. 30, 1957.

The spherical energy surface approximation used by Johnson and Whitesell to calculate the Hall coefficient and electrical conductivity when mixed ion-lattice scattering is present in a one-carrier or intrinsic semiconductor, has been extended to include arbitrary number of bands and concentrations. The formulas reduce to those of Willardson, Harman, and Beer for a system of electrons, fast and slow holes with lattice scattering. When mixed ion-lattice scattering is present in a many-band system, the magnitude of the Hall coefficient and the electrical conductivity as well as their rate of change with magnetic field can be considerably reduced compared to when only lattice scattering is present. The large contributions of the light mass carriers (i.e., light holes in p-type germanium) to the Hall coefficient and magnetoresistance are most easily reduced by small amounts of ion scattering. Under some conditions the change of the Hall coefficient with magnetic field can even be opposite to that which would take place if only lattice scattering were present.

NBS.40:003

National Bureau of Standards, Washington, D. C.

LIFETIMES IN MAGNESIUM STANNIDE (Abstract), by E. L. Sochard and J. H. Becker. [1957] [1]p. [CSO-680-56-39] Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 120, Mar. 21, 1957.

Determination of both the photoelectro magnetic effect and photoconductivity under steady state conditions permits a direct evaluation of the electron-hole pair lifetime for optically created carriers. This method has been applied to studies of lifetime as a function of temperature between 350 and 90°K on single crystals of the semiconductor Mg_2Sn (extrinsic n- and p-type concentra-

tions $10^{15} - 10^{17}/cc$). Cleaved samples, and those subjected to sandblasting and annealing treatments, have been investigated. Radiation from a Nernst glower (chopper at 3000 cps) and the use of suitable filters allowed determination of the response to various wavelength regions. The responses were linear with applied electric and magnetic fields, and approximately linear with light intensity. Samples with the highest lifetimes followed approximately $\tau \sim \exp X (-E_g/2kT)$ between 350 and 250°K.

For lower temperatures the lifetimes either decreased or remained constant. Below 150°K photovoltaic effects and large "anomalous lifetimes" occurred (not observable by transient decay checks). Bulk electron-hole pair lifetimes at 300°K ranged from 10^{-6} to 10^{-7} sec.

NBS.41:001

National Bureau of Standards, Washington, D. C.

UNIFORM TRANSIENT ERROR, by E. L. R. Corliss. [1958] [6]p. Incl. diagrs. (Research paper no. 2879) (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [CSO-680-57-1]) Unclassified

Published in Jour. Res. Nat'l. Bur. Standards, v. 61: 25-30, July 1958.

The economy of transient error is discussed. Equations describing error in power-level measurements of transients can be used to compute the design of analyzers so as to distribute transient error in a way compatible with experimental requirements. In addition, consideration of a limiting power-discrimination factor provides a measure of the largest number of bandpass filters by calculating the effective number of those overlapped on adjacent channels to yield meaningful information about a rapidly changing signal. A scanning filter can be compared with a set of bandpass filters by calculating the effective number of overlapped bandpass filters providing the same resolution as the scanning filter. The results are applicable to autocorrelation analyzers. Restrictions on rapid signal analysis also are considered for the special case in which power-level discrimination is limited by noise. (Contractor's abstract)

NBS.42:001, 002; NBS.43:001

NBS.42:001

[National Bureau of Standards, Washington, D. C.]

FROZEN FREE RADICALS, by C. M. Herzfeld and A. M. Bass. [May 1957] [6p. incl. illus. diagrs. (AFOSR-TN-57-329) (CSO-680-58-9 and CSO-680-56-21) AD 132402 Unclassified]

Also published in Scientific American, v. 196: 91-102, Mar. 1957.

A method is described by which short-lived free radicals were frozen by rapid cooling and studies made of their properties. Free radicals in a highly excited state were produced by flowing gases (water vapor, oxygen, nitrogen, and hydrogen) through a high-frequency electric discharge powered by a 2,450-megacycle medical diathermy unit. The products were then rapidly pumped to a surface cooled by liquid helium to about 4° above absolute zero, where they immediately froze into solids. Observations of the breakdown products revealed the following: Nitrogen emitted a bright blue-green glow upon freezing, attributed to isolated excited nitrogen atoms. Spectrographic examination revealed 5 intense emission lines, 3 broad bands, and many weaker bands distributed over the whole visible spectrum. Experiments with oxygen produced a clear glassy deposit upon freezing, which emitted no light and which showed 25 separate bands of absorption distributed over the whole visual spectrum and extending into the ultraviolet and infrared. When warmed to 20° absolute, this deposit changed to a violet colored solid which was identified as a mixture of oxygen and ozone with a fairly high concentration of ozone. Further warming produced additional ozone in large quantities, which suggests the possibility of using this frozen-radical method in the commercial production of ozone. Brief discussion is given to the breakdown products from discharges through hydrogen, water vapor, and ammonia gas. The possibilities presented by these studies for providing information on the role free radicals play in electric arcs, flames, interstellar dust, comets, stars, etc., and their use as new tools with which to probe the structure of solids are suggested.

NBS.42:002

National Bureau of Standards, Washington, D. C.

EFFECT OF CRYSTAL FIELD AND SPIN-ORBIT COUPLING ON MAGNETIC SUSCEPTIBILITY OF SYSTEMS WITH f^2 ELECTRON CONFIGURATION, by C. M. Herzfeld and D. B. Levine. May 27, 1958 [5p. incl. diagrs. table. (Research paper no. 2893) (AFOSR-TN-58-514) (CSO-680-58-9 and CSO-680-56-21) AD 158325 Unclassified]

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 180, May 1, 1958.

Also published in Jour. Res. Nat'l. Bur. Standards, v. 61: 117-121, Aug. 1958.

The effects of a crystal field of octahedral symmetry and of spin-orbit coupling on an ion with f^2 electron configuration are considered. Only fourth-degree terms in the crystal-field potential are taken into account. The eigenvalues and eigenvectors of the resulting 33×33 secular determinant are determined numerically on the 704 electronic computer at the National Bureau of Standards for eight values of D/ζ , where D is a crystal-field parameter, and ζ the spin-orbit coupling constant of the ion. Perturbations by an external magnetic field are computed using second-order perturbation theory. All eigenvalues are tabulated for eight values at $(-D/\zeta)$ in the range from 10^{-4} to 10^{-1} . These eigenvalues can be adapted directly to any finite nonzero positive value of ζ and, by interpolation, for values of D/ζ not tabulated. The magnetic susceptibility of a powder is calculated and displayed as a function of temperature and D/ζ , for $\zeta = \pi, 10^3 \text{ cm}^{-1}$, and $5 \times 10^2 \text{ cm}^{-1}$. The relation of the results of the calculations to measurements on compounds of U^{+4} is discussed. (Contractor's abstract)

NBS.43:001

National Bureau of Standards, Washington, D. C.

HEATING EFFECTS ACCOMPANYING PHOTOCONDUCTIVITY AND THE PHOTO-ELECTRO-MAGNETIC EFFECT IN SEMICONDUCTORS (Abstract), by I. I. Sochard and J. H. Becker. [1958] [1p. (CSO-680-58-15) Unclassified]

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 114, Mar. 27, 1958.

A well-known method for determination of lifetimes of electron-hole pairs in semiconductors uses photoconductivity and photoelectromagnetic (PEM) short-circuit current measurements. Sample heating always occurs and produces "bolometer" action and "thermo-electromagnetic" effects (diffusion of thermally excited carriers in a magnetic field). These can seriously hinder evaluation of the lifetimes, especially for intrinsic materials with small ambipolar diffusion lengths ($l = \sqrt{D\tau}$). When the heating phenomena are dominant the thermal diffusivity can be estimated. In lifetime measurements it is customary to modulate the incident radiation at

NOL.01:002; NRL.01:001;
NRL.02:001, 002

audiofrequencies. Increasing this "chopping" frequency f decreases the thermal signals (for "thick samples,"

$Bol \sim f^{-1}$, $TEM \sim f^{-1/2}$) which facilitates lifetime measurements; for a lifetime determination in Mg_2Sn

$f > 10^4$ cps is required above room temperature. Data at "chopping" frequencies between 20 and 13,000 cps will be shown for intrinsic and extrinsic samples of Mg_2Sn . Analysis will include an estimate of the minimum lifetimes determinable by the PC-PEM method in terms of the "chopping" frequency and known electrical and thermal properties of a semiconductor. (Contractor's abstract)

NOL.01:002

Naval Ordnance Lab., Corona, Calif.

INFRA-RED SPECTRA OF FREE RADICALS, by K. N. Tanner and R. L. King. [1958] [3]p. incl. diagrs. refs. (AFOSR-TR-58-113) [MIPR-670-55-40] AD 201773
Unclassified

Also published in Nature, v. 181: 963-965, Apr. 5, 1958.

It has been shown that with the use of fast photo-conductive detectors, infra-red spectroscopy can be applied to the study of free radicals and other short-lived molecules with conditions of resolution approaching those of conventional instruments using thermal detectors. Furthermore, by direct photometric techniques, kinetic studies can be made easily and relatively accurately.

NRL.01:001

Naval Research Lab., Washington, D. C.

APPLICATION OF LUMINESCENCE CHANGES IN ORGANIC SOLIDS TO DOSIMETRY, by J. H. Schulman, H. W. Etzel, and J. G. Ailard. [1957] [4]p. incl. diagrs. refs. [CSO-670-54-8]
Unclassified

Published in Jour. Appl. Phys., v. 28: 792-795, July 1957.

The degradation of photoluminescence in anthracene and in naphthalene has been studied under gamma-ray and electron irradiation over the range 3×10^5 to 2×10^8 rep. For both materials the variation of brightness with CO^{60} gamma-ray dose D , in rep, may be represented by $(I/I_0) = (1 + AD)^{-1}$, where $A = 8.5 \times 10^{-7}$ for anthracene and $A = 14 \times 10^{-7}$ for naphthalene. Irradiation also produces a radiophotoluminescence in naphthalene, with emission in the visible spectral region. Both the degradation and radiophotoluminescence are stable with time at room temperature. The employment of these effects for dosimetry is discussed. (Contractor's abstract)

NRL.02:001

Naval Research Lab., Washington, D. C.

THE IRRADIATION OF POLYVINYL METHYL ETHER WITH ELECTRONS AND GAMMA RAYS TO FORM ELASTOMERS, by D. Duffey. Aug. 19, 1957, 33p. incl. diagrs. tables, refs. (Rept. no. 4938) [Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under CSO-680-56-12]
Unclassified

Polyvinyl methyl ether and mixtures of this ether with a variety of powdered fillers were irradiated with electrons from a Van de Graaff and gamma rays from cobalt-60. The ether crosslinked on irradiation, however, fillers were necessary to give products with much strength. The fillers, carbon black, magnesia, silica, iron oxide, and calcium phosphate produced significant reinforcement. Ordinary chemical methods of cross-linking, or vulcanization, were ineffective. The optimum amount of fillers for strength was about 30% of the mixture by volume, and the required radiation levels were the order of 40 megarontgens. Tensile strengths of over 1500 psi with elongations at breaking of 100 to 200% were obtained. The products swelled in the solvents of the crude ether. In particular, cold water swelled the products, which could be a serious limitation to many uses. Some liquids, such as straight chain hydrocarbon and caustic solution, did not effect the product appreciably. (Contractor's abstract)

NRL.02:002

Naval Research Lab., Washington, D. C.

LUMINESCENCE OF Z CENTERS IN KCl: Sr CRYSTALS, by E. J. West and W. D. Compton. [1957] [4]p. incl. diagrs. [CSO-600-56-12]
Unclassified

Published in Phys. Rev., v. 108: 576-579, Nov. 1, 1957.

A search has been made for emissions that are characteristic of the Z_1 and Z_2 centers in additively colored crystals of KCl containing strontium. No emission was found for the Z_1 center. The Z_2 center was found to emit at 1.14μ at 77°K. A study of the polarization of the emission of the Z_2 center with polarized exciting light leads to the conclusion that this center is of high symmetry. A study of the transfer of energy between centers that have been formed by irradiating with F light leads to the conclusion that these centers (i.e., F , Z_1 , R_1 , R_2 , M , and a center with absorption at $860 m\mu$) are formed in the neighborhood of each other. (Contractor's abstract)

NRL.02:003; NRL.03:001;
NRL.04:001; NEL.02:001; NEC.01:001

NRL.02:003

Naval Research Lab., Washington, D. C.

SYMMETRY PROPERTIES OF THE V_1 CENTER, by J.Lambe and E. J. West. [1957] [4]p. incl. diagrs.
[CSO-660-56-12] Unclassified

Published in Phys. Rev., v. 106: 634-637, Nov. 1, 1957.

The symmetry of the V_1 center was studied using a technique of bleaching with polarized light. The V_1 band in KCl and KBr produced by x-rays and 2-mev electron bombardment was examined. In addition, the effect of bleaching with polarized light on the phosphorescent emission of KCl was observed. It is concluded that the center responsible for the V_1 absorption band in KCl and KBr was cubic symmetry insofar as its optical absorption is concerned. The phosphorescent emission of KCl became anisotropic under polarized bleaching light, indicating the presence of a center of noncubic symmetry. This second center has a [011] axis of symmetry. (Contractor's abstract)

NRL.03:001

Naval Research Lab., Washington, D. C.

CRACK-EXTENSION-FORCE NEAR A RIVETED STIFFENER, by J. P. Romualdi, J. T. Frasier, and G. R. Irwin. Oct. 11, 1957, 20p. incl. diagrs. tables. (Rept. no. 4956) (AFOSR-TN-56-140) (MIPR-680-56-47) AD 152167 Unclassified

Knowledge of the characteristic value of the crack-extension-force for onset and arrest of rapid fracturing should, conceptually, permit direct calculation of the load-bearing capacity of structural components from the viewpoint of fracture fail-safe design. This possibility is illustrated by two examples of calculation of the crack-extension-force in the presence of rivet forces. One case is a crack centrally located at a stiffener, and the second case is a crack centrally located between stiffeners. The results indicate that in both cases the riveted stiffeners serve as effective crack arresters. The calculations were checked experimentally, and satisfactory agreement was obtained. Errors in strain-gage determinations of the crack-extension-force, it was found, become negligible when an appropriate correction for gage position is applied.

NRL.04:001

Naval Research Lab., Washington, D. C.

PROCEEDINGS OF THE SECOND HYPERVELOCITY AND IMPACT EFFECTS SYMPOSIUM, VOL. I, Washington, D. C. (May 22-24, 1957), ed. by W.

Mannix, W. W. Atkins, and R. E. Clark. Washington, Naval Research Lab., Dec. 1957, 212p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Naval Research Lab. and Air Force Office of Scientific Research) Unclassified

Three sessions were held in the symposium and the topics discussed were: (1) the acceleration of small particles by either explosives or by means of an auxiliary light gas gun, (2) the distribution of meteors and the effect of meteor impact on surfaces, (3) the impact and cratering of high velocity particles, (4) the acceleration of particles by electromagnetic means, and (5) separate papers on magnetoaerodynamics, properties of air at high temperatures, and the development of hypersonic wind tunnels.

NEL.02:001

[Nelson, W. C.] Ann Arbor, Mich.

OPTICAL METHODS FOR EXAMINING THE FLOW IN HIGH-SPEED WIND TUNNELS. PART I. SCHLIEREN METHODS. PART II. INTERFEROMETER METHODS, by D. W. Holder, R. J. North, and G. P. Wood. Nov. 1956, 146p. incl. illus. diagrs. tables, refs. (AGARDograph no. 23) (In cooperation with National Physical Lab. (Gt. Brit.) and NACA) (AFOSR-TN-57-336) [AF 16(600)1322] AD 132410 Unclassified

This paper reviews the present state of knowledge concerning the use of schlieren, direct-shadow, and interferometer techniques for visualizing and photographing the flow in high-speed wind tunnels. Emphasis is placed on the most widely used techniques, but brief details are also given of methods which are in an early stage of development, or which are useful only in a limited range of investigations. Information on suitable light sources and photographic materials is included. (Contractor's abstract)

NEC.01:001

New Mexico Coll. of Agriculture and Mechanic Arts. Physical Science Lab., State College.

INTERFERENCE PHENOMENA IN A CIRCULAR WAVEGUIDE CONTAINING A COAXIAL FERRITE CYLINDER OF FINITE LENGTH, by R. Dressel. Jan. 1958, 46p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-135) (AF 16(600)1597) AD 152162 Unclassified

The scattering formulation is used to obtain a theoretical description of the interference phenomena encountered in a circular waveguide containing a coaxial ferrite cylinder of finite length. Complete solutions are derived for the amplitude, polarization and phase of both transmitted and reflected components. Measurements of the important parameters provide values for calculating the waveguide effects. Results are compared with waveguide

NEU.01:001 - NEU.01:004

observations designed to evaluate the functional dependence upon ferrite length, diameter, and magnetization. (Contractor's abstract)

NEU.01:001

New Mexico U., Albuquerque.

ORGANIZATION OF AND REACTIONS TO THE INTERDISCIPLINARY PROGRAM IN THE BEHAVIORAL SCIENCES SUPPORTED BY THE AIR FORCE OFFICE OF SCIENTIFIC RESEARCH AT THE UNIVERSITY OF NEW MEXICO, 1957-1958, by R. D. Norman. Nov. 15, 1958, 66p. incl. tables, refs. (AFOSR-TN-58-1099) (AF 49(638)33) AD 207800 Unclassified

This report is organized into three major sections. Part I is concerned with a general description of the program — its purpose and organization, selection of participants, etc. Part II discusses reactions to some general aspects of interdisciplinary programs. Part III is devoted to observations on the functioning of the New Mexico effort specifically.

NEU.01:002

New Mexico U., Albuquerque.

A FUNCTIONAL ANALYSIS OF AUTHORITY, by J. S. Adams and A. K. Romney. [1958] 60p. incl. diagrs. refs. (In cooperation with Stanford U., Calif.) (AFOSR-TN-58-1100) (AF 49(638)33) AD 207821 Unclassified

Also published in Psychol. Rev., v. 66: 234-251, July 1959.

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 227-256, 1962.

An analysis was made of a social interaction in which one person exercises control over the behavior of one or more other persons. A person A was considered to have authority over B, in a given situation, when a response of A, under the control of deprivation or aversive stimulation and specifying its own reinforcement, is reinforced by B. Authority so defined was analyzed as a function of the following variables: (1) reinforcing stimulus variables; (2) deprivation and aversive stimulus variables affecting A; and (3) discriminative stimulus variables. A paradigm of an authority sequence was analyzed in terms of these variables. Series of functionally related sequences were defined as sequences under the control of one another or of common variables. Three classes of functionally related consequences were analyzed: (1) where one sequence exercised functional control over another; (2) where a common variable exercised functional control over 2 or more sequences; and (3) authority conflict. The study suggests how authority

evolves, is maintained, and may be weakened. In addition, the analysis showed that, if authority has any locus, it is in all interactors in the sense that behavior on the part of all interactors is essential for authority to exist. (ASTIA abstract)

NEU.01:003

New Mexico U., Albuquerque.

INTERNAL REFERENTS AND THE CONCEPT OF REINFORCEMENT, by W. Bevan and R. Adamson. [1958] 31p. incl. diagrs. refs. (In cooperation with Emory U., Atlanta, Ga.) (AFOSR-TN-58-1101) (AF 49(638)33) AD 207822 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 453-472, 1962.

A reconceptualization is outlined of reinforcement based on assumptions that the organism is capable of averaging input over time, thus deriving internal norms, that the magnitude of reinforcement depends directly on these norms, that reinforcement exerts its influence upon performance through its effect upon tension level, and that there is a curvilinear relation between tension level and performance efficiency. The results of experiments relating to the validity of these assumptions are presented; and implications of the present point of view for understanding changes in the efficacy of reinforcing agents, partial reinforcement, extinction and reacquisition, and the performance of anxious and non-anxious subjects are reviewed. (Contractor's abstract)

NEU.01:004

New Mexico U., Albuquerque.

THE EFFECTS OF VERBAL EXPRESSION OF HOSTILITY, by R. DeCharms and M. E. Rosenbaum. [1958] 14p. incl. table. (In cooperation with Iowa State U., Ames) (AFOSR-TN-58-1102) (AF 49(638)33) AD 207823 Unclassified

The experiment reported was an examination of the relationship between aggressive statements directed toward an aggressor and residual hostility toward the aggressor. Forty male subjects (Ss) engaged in interaction and by prearrangement were verbally attacked. They were then permitted to reply to the attacker and then wrote a personality sketch of him. Results showed that for Ss with high self esteem and those with low self esteem there was a high positive correlation between the amount of hostility shown in the reply to the attacker and that shown on the subsequent personality sketch. In addition, it was found that Ss with low self esteem showed a large and significant increase in hostility from the first to the second measure, but this was not true for Ss with high

NTU.01:005 - NEU.01:007

self esteem. These results were interpreted as casting doubt on a simple catharsis hypothesis of hostility reduction. (Contractor's abstract)

NEU.01:005

New Mexico U., Albuquerque.

THE EMERGENCE AND FUNCTIONING OF OPINION LEADERSHIP: SOME CONDITIONS OF INFORMAL INFLUENCE TRANSMISSION, by M. L. DeFleur. [1958] 30p. incl. refs. (In cooperation with Indiana U., Bloomington) (AFOSR-TN-58-1103) (AF 49(638)33) AD 207824 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 257-278, 1962.

Ten conditions and factors which may be operative in the emergence and functioning of opinion leadership in informal groups were formulated and discussed in an effort to provide a guide for exploratory small group studies. The conditions and factors are as follows: (1) the degree to which the relevant context of ideas is regarded as important by the group; (2) the degree to which the potential opinion leader relays the relevant context of ideas to the other group members; (3) the degree to which the other group members themselves have access to the relevant context of ideas; (4) the degree to which the potential opinion leader is viewed by the group as competent or expert with regard to the specific context of ideas; (5) the degree to which the other group members view themselves as lacking competence or expertness in the relevant context of ideas; (6) the degree to which the potential opinion leader has functioned as an opinion leader in relating other contexts of ideas to the group; (7) the nature of the potential opinion leader's group membership; (8) the nature of the organizational basis and the structure of the interpersonal network; (9) the degree to which the potential opinion leader has statuses, prestige, or authority in socio-cultural systems external to the immediate group; and (10) the degree to which the group experiences positive or negative reinforcement following any adoption of the potential opinion leader's suggestions within the relevant context of ideas. (ASTIA abstract)

NEU.01:006

New Mexico U., Albuquerque.

SOME REQUIREMENTS FOR QUANTITATIVE METHODS IN BEHAVIORAL SCIENCE RESEARCH, by P. H. DuBois and D. Gold. [1958] 41p. incl. diagrs tables. (In cooperation with Washington U., St. Louis, Mo.) (AFOSR-TN-58-1104) (AF 49(638)33) AD 207825 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 4-65, 1962.

Some requirements are discussed for quantitative methods of analysis in behavioral research in relation to the order of measurement which characterizes the data. For categorical data, it is considered that the partitioning of chi-square answers questions about the differences between degrees of association in a set of partial contingency tables, and that a limited method of decomposing a total association answers questions about the proportion of the total association between two variables that can be accounted for by the relationship of each to a third. With interval data two primary problems of interest to the behavioral scientist are discussed: (1) the development of means of identifying unitary variables manifested in diverse acts of behavior by groups of individuals, and (2) the application of factor analytic techniques to determining the basic variables underlying a set of observed variables. While these methods have already had wide-spread application, it appears that their further perfection would help to provide tools needed for further discoveries in this area of research. Several leads for their further refinement are noted. (Contractor's abstract)

NEU.01:007

New Mexico U., Albuquerque.

THREE DIMENSIONS OF RANK: A STUDY OF ACADEMIC PRESTIGE, by R. Ellis. [1958] 18p. incl. tables. (In cooperation with Stanford U., Calif.) (AFOSR-TN-58-1105) (AF 49(638)33) AD 207826 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 189-200, 1962.

An exploratory analysis of the conceptual dimensions of rank differentiation is reported. Data for the present study were provided by "prestige judgments" which psychology graduate students in a large metropolitan university made of their faculty. It was found that: (1) sufficiently similar judgmental standards were used by the students to evidence the operation of a commonly defined rank system; (2) a professor's rank (i.e., overall prestige) in the university, as well as being related to the formal status he holds in the institution and his effectiveness in carrying out the positional mandates, was related to the possession of inherited or acquired personal qualities which the students deemed appropriate for the status incumbent; and (3) rank distinctions in this institutional setting were judged in affectively-neutral fashion, both in terms of the criteria of rank employed and in terms of the impersonal manner with which rank and its criteria were judged. (Contractor's abstract)

NEU.01:008 - NEU.01:012

NEU.01:008

New Mexico U., Albuquerque.

CONFLICT, COOPERATION, AND CHOICE. NOTES FOR AN EXPLORATION OF CONCEPTUAL RELATIONSHIPS, by R. M. Goldman. [1958] 46p. incl. refs. (In cooperation with Michigan State U., East Lansing) (AFOSR-TN-58-1106) (AF 49(638)33) AD 207827

Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 410-439, 1962.

The current theoretical status of social conflict, social cooperation, and human decision-making was reviewed. Notes for a new theory of conflict and cooperation are presented in the form of definitions and comments. The following were defined and discussed: (1) social conflict; (2) psychological individual; (3) disagreement and agreement; (4) expectation; (5) position; (6) task expectations; (7) social group; (8) goal; (9) sanction; (10) deprivation; (11) role; (12) incumbency; and (13) choice.

NEU.01:009

New Mexico U., Albuquerque.

THE CHANGING ROLE AND STATUS OF THE SCIENTIST AND ACADEMIC IN AMERICAN SOCIETY, by H. M. B. Hurwitz. [1958] 1v. incl. refs. (In cooperation with London U., Birkbeck Coll. (Gt. Brit.)) (AFOSR-TN-58-1107) (AF 49(638)33) AD 207828

Unclassified

A discussion is presented of the scionad, a neologism which serves to designate a newly emerging socio-economic class. The scionad is considered to be an individual who has secured professional, specialized training, either in the physical, biological or social sciences, yet who has become bureaucratized (and whose profession has become bureaucratized). A series of appendixes are included which reveal the extent to which relevant information was obtained.

NEU.01:010

New Mexico U., Albuquerque.

THEORY AND RESEARCH IN BEHAVIORAL SCIENCE, by W. Iltelson, M. Landau, and H. Proshansky. [1958] 28p. (In cooperation with Brooklyn Coll., N. Y.) (AFOSR-TN-58-1108) (AF 49(638)33) AD 207829

Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U.,

Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 7-24, 1962.

The following topics are discussed: (1) the historical roots of behavioral science; (2) the definition of behavioral science; (3) some implications of behavioral science; and (4) the conduct of research in behavioral science.

NEU.01:011

New Mexico U., Albuquerque.

THE MEASUREMENT OF PERCEIVED PERSONALITY TRAIT RELATIONSHIPS, by D. N. Jackson. [1958] 18p. incl. refs. (In cooperation with Pennsylvania State U., University Park) (AFOSR-TN-58-1109) (AF 49(638)33) AD 207830

Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 177-188, 1962.

Previous research in forming impressions of personality was reviewed. A survey and evaluation was presented of methods for the study of the perception of personality, with particular emphasis upon the measurement of perceived trait relationships. It was concluded that multidimensional successive intervals was particularly promising for research in this area, because of its highly developed mathematical rationale, and because of the likelihood that its n-dimensional Euclidean model will provide a formal system for representing faithfully verbal constructs. (Contractor's abstract)

NEU.01:012

New Mexico U., Albuquerque.

INTERNAL VERSUS EXTERNAL CONTROL OF REINFORCEMENTS. A MAJOR VARIABLE IN BEHAVIOR THEORY, by J. B. Rotter, M. Seeman, and S. Liverant. [1958] 66p. incl. refs. (In cooperation with Ohio State U., Columbus) (AFOSR-TN-58-1110) (AF 49(638)33) AD 207836

Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 473-516, 1962.

A kind of generalized expectancy which affects changes in behavior potential and expectancies by reducing the amount of learning that takes place as a function of new experience is investigated. The implications of this concept for a number of broader social variables is discussed with particular emphasis on the concept of alienation. Progress is reported in the development of a new individual measure of the variable being studied. An

NEU.01:013 - NEU.01:018

analysis is also made of whether or not an individual believes that his own behavior, skills, or internal dispositions determine what behavior or attitude reinforcement he receives.

NEU.01:013

New Mexico U., Albuquerque.

INTELLIGENCE. TIME FOR A CHANGE, by S. Liverant. [1958] 23p. incl. refs. (In cooperation with Ohio State U., Columbus) (AFOSR-TN-58-1111) (AF 49(638)33) AD 207837 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 88-85, 1962.

The concept of intelligence was analyzed with respect to its ability to explain behavior. Evidence from the literature of the past 20 yr was used to challenge accepted conceptions of the general and innate nature of intelligence. The suggestion was made that the term intelligence be relegated to a descriptive function applicable to certain kinds of behavior whose explanation can be attempted by the continued development of existing constructs. In addition, it was suggested that I.Q. tests be interpreted as culturally expected standards of academic achievement involving a number of complexly interrelated variables (e.g., motives, habits, expectancies, reinforcements, etc.) to account for the results.

NEU.01:014

New Mexico U., Albuquerque.

A DESCRIPTIVE THEORY OF COMMUNICATION, by H. MacLay. [1958] 55p. (In cooperation with Illinois U., Urbana) (AFOSR-TN-58-1112) (AF 49(638)33) AD 207838 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 201-228, 1962.

This report is a first attempt to develop a theoretical basis for describing some aspects of the process of communication. It is a descriptive theory in that its aim is confined to describing what occurs in a communicative process. The author is interested in defining the units of communicative behavior in the same way that a structural linguist is concerned with the units of language behavior. The result of this attempt is a model which describes communication in terms of several variables and the rules by which they combine. A set of procedures for discovering the units of communicative behavior is also presented.

NEU.01:015

New Mexico U., Albuquerque.

DETERMINISTIC THEORIES, by R. Montague. [1958] 84p. incl. refs. (In cooperation with California U., Los Angeles) (AFOSR-TN-58-1113) (AF 49(638)33) AD 207839 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 325-370, 1962.

An investigation was made to analyze the properties of the notions of a deterministic theory and a deterministic system. This investigation is conducted within metamathematics in the wide sense and employs the apparatus of syntax and set theory in an intuitive manner, making no attempt to trace it back to its theoretical foundations. Explicit definability and determinism are discussed in which the metamathematical methods employed are deeper and contribute to the well-known n-body problem of physics.

NEU.01:018

New Mexico U., Albuquerque.

A THEORETICAL ANALYSIS OF CONFLICT, by A. Pepitone and S. Feshbach. [1958] 27p. incl. refs. (In cooperation with Pennsylvania U., Philadelphia) (AFOSR-TN-58-1114) (AF 49(638)33) AD 207840 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 440-452, 1962.

An attempt was made to develop a formal treatment of the notion of conflict. Attention was focused upon the immediate source of most human conflict, namely, the psychological environment of the individual (an environment which has predictable effects upon the organism). This environment, at any given time, was considered a finite set of behavior possibilities. These possibilities were regarded as alternatives in choice or decision situations with states and positions in addition to the kind of actions that follow formal decisions. The following conceptual tools were used in developing a formalized treatment of conflict: (1) positive value (this quantity is conceptually equivalent to the notion of goal, reward, positive valence, etc.); (2) negative value (this quantity is the equivalent of punishment, negative valence, avoidance, etc.); and (3) difficulty (associated with each positive value or negative value are quantities which represent the difficulty (work, cost, etc.) involved in realizing the positive value or in minimizing the negative value).

NEU.01:017 - NEU.01:020

Three simple conflict types were analyzed. In addition, a discussion is presented of uncertainty, distance and time gradients, sources of conflict, consequences of conflict, compromise solutions, and defense mechanisms.

NEU.01:017

New Mexico U., Albuquerque.

A PROGRAM FOR RESEARCH ON EXPERIMENTS IN SOCIAL PSYCHOLOGY, by H. W. Riecken. [1958] 23p. (In cooperation with Minnesota U., Minneapolis) (AFOSR-TN-58-1115) (AF 49(638)33) AD 207841
Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 25-41, 1962.

The particular features of the social situation in which data are collected on human behavior, and the processes of negotiation between investigator and subject through which they come to understand how to behave in the situations, were investigated. A study was begun to determine the sources of error in the investigation of social behaviors inherent in the investigative method used.

NEU.01:018

New Mexico U., Albuquerque.

NOTES ON A CONSTRUCTIONAL FRAMEWORK FOR A THEORY OF ORGANIZATIONAL DECISION MAKING, by R. S. Rudner and R. J. Wolfson. [1958] 72p. incl. refs. (In cooperation with Michigan State U., East Lansing) (AFOSR-TN-58-1116) (AF 49(638)33) AD 207842
Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 371-409, 1962.

A preliminary treatment is given of the study of the construction of a definitional framework of concepts held to be pivotal in any adequate theory of organizational decision making. The definitional framework is comprised of 91 definitions, grouped into 4 related categories. The categories are (1) a pool of preliminary concepts, (2) decision behavior, (3) conflict and cooperation, and (4) decision making in organizations. The number of extralogical primitive terms indigenous to the behavioral sciences is minimized in favor of terms which have received explication in physical science.

NEU.01:019

New Mexico U., Albuquerque.

INFORMATION STORAGE IN GROUPS, by R. B. Zajonc. [1958] 10p. incl. diagrs. (In cooperation with Michigan U., Ann Arbor) (AFOSR-TN-58-1117) (AF 49(638)33) AD 207843
Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 279-290, 1962.

An attempt in the area of memory is made to predict group performance on the basis of individual abilities interacting with one another. This approach consists of a combinatorial analysis of individual products and abilities. By analyzing the recall potential of individual members, derivations are made regarding the storage of information in the group as a whole. The problem is presented of how a given amount of information should be distributed among a number of individuals so as to assure maximal recovery of the information. By imposing a set of restrictions, a solution is obtained by generating a constant distribution value independent of the amount of information and the number of individuals involved. A set of solutions obtained by specifying various restrictive conditions provides standards against which empirical results can be compared.

NEU.01:020

New Mexico U., Albuquerque.

THE RATIONAL PROPERTIES OF SCIENTIFIC AND COMMON SENSE ACTIVITIES, by H. Garfinkel. [1958] 27p. incl. tables, refs. (In cooperation with California U., Los Angeles) (AFOSR-TN-58-1118) (AF 49(638)33) AD 207844
Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 304-324, 1962.

An inquiry was made into the various rational properties of conduct as well as the conditions of a social system under which various rational behaviors occur. The following behaviors are discussed: (1) categorizing and comparing; (2) tolerable error; (3) search for means; (4) analysis of alternatives and consequences; (5) strategy; (6) concern for timing; (7) predictability; (8) rules of procedure; (9) choice; (10) grounds of choice; (11) compatibility of ends-means relationships with principles of formal logic; (12) semantic clarity and distinctness; (13) clarity and distinctness for its own sake; and (14) compatibility of the definition of a situation with scientific knowledge. The hypothesis that the scientific

NEU.01:021 - NEU.01:024

rationalities can be employed only as ineffective ideals in the actions governed by the presuppositions of everyday life was recommended. (ASTIA abstract)

NEU.01:021

New Mexico U., Albuquerque.

UNIFORMITIES IN CULTURE: IDEAS WITH HISTORIES, by E. Rose. [1958] 30p. incl. tables, refs. (In cooperation with Colorado U., Boulder) (AFOSR-TN-58-1119) (AF 49(638)33) AD 207845 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 154-176, 1962.

A review is presented on the following topics: (a) culture elements; (b) records of uniformities; (c) historical characteristics of cultural ideas; (d) problems for historical inquiry; (e) behavioral sources of cultural uniformities; and (f) culture and consensual behavior.

NEU.01:022

New Mexico U., Albuquerque.

COGNITIVE STRUCTURE AND SOCIAL STRUCTURE: A REVIEW OF RELEVANT CONCEPTS, by W. A. Scott. [1958] 32p. incl. refs. (In cooperation with Colorado U., Boulder) (AFOSR-TN-58-1120) (AF 49(638)33) AD 207846 Unclassified

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 86-118, 1962.

This report consists of the following topics: (1) definitions of cognitive, personality, and social structure; (2) properties of the cognitive structure; (3) cognitive elements; (4) properties of social structures; (5) relational properties of social structures; (6) properties of cultural systems; (7) relations between cognitive structure and social structure; (8) normative influences of social structures; (9) differing reactions to pressures toward consensus; and (10) position in group as a determiner of cognitive structure.

NEU.01:023

New Mexico U., Albuquerque.

RESPONSE REINFORCEMENT, VALUE-ATTITUDE CONSISTENCY, AND ATTITUDE CHANGE, by W. A. Scott. [1958] 25p. incl. tables, refs. (In cooperation

with Colorado U., Boulder and Northwestern U., Evanston, Ill.) (AFOSR-TN-58-1121) (AF 49(638)33) AD 207847 Unclassified

Also published in Sociometry, v. 22: 219-229, 1959.

Also published in Second Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1958, New York, Pergamon Press, v. 2: 119-130, 1962.

Two experiments were performed in which subjects (Ss) attitudes were changed by inducing them to express, in debate or structured discussion, opinions which they did not initially hold, then rewarding them for the verbal behavior. The first experiment served to confirm results previously reported by W. A. Scott (Jour. Abnormal Social Psychol., v. 55: 72-75, 1957), and further indicated that the procedure was effective for Ss with extreme, moderate, or neutral attitudes. The newly acquired attitude showed a significant degree of saving, as measured by a subsequent test approximately 10 days later. The second study was aimed at testing the hypothesis that Ss whose initial attitudes were cognitively consistent would be more resistant to attitude change than cognitively inconsistent Ss. On the basis of pretest responses to a set of questions concerning 8 values, and of the perceived relevance of the issue under discussion to each of the values, Ss were classified as either cognitively consistent or inconsistent in their attitudes toward the issue. As predicted, the cognitively consistent Ss were less likely to change their attitudes under the experimental conditions than were the cognitively inconsistent Ss. (ASTIA abstract)

NEU.01:024

New Mexico U., Albuquerque.

DIRECT AND VICARIOUS REDUCTION OF HOSTILITY, by M. E. Rosenbaum and R. DeCharms. [1958] 25p. incl. diagr. table, refs. (In cooperation with Iowa State U., Ames and Washington U., St. Louis) (AFOSR-TN-58-1122) (AF 49(638)33) AD 207848 Unclassified

Also published in Jour. Abnormal Social Psychol., v. 60: 105-111, 1960.

The effectiveness of vicarious experience in reducing hostility toward an instigator was examined. Hypotheses which are related to the role of communication in the reduction of aggressive impulses were tested. Fifty subjects (Ss) participated in a simultaneous interaction in which each was verbally attacked by a standard tape-recording. The experimental conditions were as follows: (1) Ss sat in silence after the attack; (2) Ss heard a third person denounce the attacker; and (3) Ss were permitted to communicate back to the attacker themselves. Ss in each group were classified as to level of self-esteem. A measure of residual hostility toward the attacker constituted the primary dependent variable. Results were

NEU.01:025-027; NEU.02:001, 002

obtained which gave support to the hypotheses that both direct and vicarious communication to the aggressor reduce hostility for Ss with low self-esteem. High self-esteem Ss were not strongly instigated to aggression, and that they showed some insensitivity to cues presented by other persons since they seemed not to discriminate between the aggressor and the other more benign person.

NEU.01:025

New Mexico U., Albuquerque.

COMMON FATE, SIMILARITY, AND OTHER INDICES OF THE STATUS OF AGGREGATES OF PERSONS AS SOCIAL ENTITIES, by D. T. Campbell. [1958] [10]p. incl. diagr. table, refs. (In cooperation with Northwestern U., Evanston, Ill.) (AF 49(638)33)

Unclassified

Published in Behavioral Science, v. 3: 14-25, Jan. 1958.

Also published in First Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1957, New York, Pergamon Press, v. 1: 185-201, 1960.

Before a social aggregate can be examined for its status as an organic system its status as entity must be evaluated. Indices of common-fate, similarity, and proximity may be appropriate to this task. Social groups as entities do not have an epistemological status different from such middle-sized entities as stones and rats, but are apt to be fuzzier, less discrete, less multiply confirmed, and in this sense less real. The degree of entitativity and the possibility of a sociology at a level of analysis separate from psychology is a matter for empirical determination rather than a priori decision. (Contractor's abstract)

NEU.01:026

New Mexico U., Albuquerque.

STOCHASTIC CHOICE AND SUBJECTIVE PROBABILITY, by J. S. Chipman. Sept. 22, 1958, 38p. incl. illus. tables, refs. (Technical rept. no. 2) (In cooperation with Minnesota U., Minneapolis) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)33 and Office of Naval Research under Nonr-258200) AD 203445

Unclassified

Also published in First Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, June-Aug. 1957, New York, Pergamon Press, v. 1: 70-95, 1960.

An investigation was conducted on (1) the stochastic nature of choice; and (2) the characterization of events in terms of the nature and the amount of information associated with them.

NEU.01:027

New Mexico U., Albuquerque.

A "PURE" MEASURE OF PERCEPTUAL DEFENSE UNCONTAMINATED BY RESPONSE SUPPRESSION, by A. Mathews and M. Wertheimer. [1958] [4]p. incl. tables. (In cooperation with Colorado U., Denver) (AF 49(638)33)

Unclassified

Published in Jour. Abnormal Social Psychol., v. 57: 373-376, Nov. 1958.

Using a tachistoscopic recognition technique, an experiment was designed that provided measures both of "perceptual defense" and of response suppression. The "perceptual defense" measure could be corrected by the response suppression measure to yield a "pure" perceptual defense measure. With this method, it was found that subjects scoring high on the hysteria scale of the MMPI demonstrate a significant perceptual defense effect over and above a response suppression effect, when confronted by words preselected so as to be emotional for each subject individually. It is therefore concluded that perceptual defense effects cannot be accounted for entirely on the basis of response suppression. (Contractor's abstract)

NEU.02:001

New Mexico U. Dept. of Physics, Albuquerque.

DEVELOPMENT OF A LARGE SCINTILLATOR FOR OBSERVATION OF EXTENSIVE AIR SHOWERS, by J. R. Green. Preliminary rept. June 20, 1957, 5p. (AFOSR-TN-57-432) (AF 49(638)34) AD 136422; PB 135087

Unclassified

Presented at the Cosmic Ray Conf., Varenna, Italy, June 21-26, 1957.

A large scintillator has been constructed for the purpose of investigating high energy extensive air showers of the cosmic radiation.

NEU.02:002

New Mexico U. Dept. of Physics, Albuquerque.

A LARGE SCINTILLATOR FOR OBSERVATION OF COSMIC RAYS, by J. R. Green. July 22, 1957 [16]p. incl. diagrs. (AFOSR-TN-57-433) (AF 49(638)34) AD 136423; PB 135155

Unclassified

NEU.02:003; NYU.08:001-003

Also published in Rev. Scient. Instruments, v. 29: 10-14, Jan. 1958.

A liquid scintillator having an area of 5 sq m was developed for observation of cosmic rays. Details of construction and of certain of the electronic circuits are given.

NEU.02:003

New Mexico U. Dept. of Physics, Albuquerque.

LINEAR SWEEP CIRCUIT, by J. R. Green and P. O. Schele. July 22, 1957 [12]p. incl. diagrs. table. (AFOSR-TN-57-434) (AF 49(638)34) AD 136424; PB 135088 Unclassified

A simple electronic circuit employing feedback is described that will produce a positive pulse whose amplitude is proportional to the duration of a positive input pulse. The circuit is analyzed using fundamental principles. The theory of propagation of errors is used in comparing the observed and the predicted behavior of the circuit.

New York State Coll. of Ceramics, N. Y. see
Alfred U. New York State Coll. of Ceramics, N. Y.

NYU.08:001

New York U., N. Y.

THE SPECTRUM OF INDIVIDUAL INTERACTION CHARACTERISTICS: AN INTER-DIMENSIONAL ANALYSIS, by E. F. Borgatta, L. S. Cottrell, Jr., and J. H. Mann. Feb. 1958 [40]p. incl. diagrs. tables. (In cooperation with New Mexico U. Albuquerque, AF 49-(638)33) (AFOSR-TN-58-422) (AF 49(638)195) AD 158225 Unclassified

Also published in Psychol. Repts., v. 4: 279-319, 1958.

This research attempted to replicate work reported by Carter that indicated three factors were sufficient to account for most of the variance in the ratings of interaction. Forty-seven graduate students participated in 5 small groups in roles which rotated among the members. Rankings of peers were obtained for 16 personality trait names, 24 behavioral descriptive categories, and other salient variables. Bales' category system was utilized in classifying the groups behavior. Intercorrelations were calculated and factor-analyzed according to the complete centroid technique. Two major factors, individual assertiveness and Sociability, extracted from a matrix of 18 trait names and 24 behavioral descriptive phrases, corresponded directly to Carter's work. Three other factors were found: manifest intelligence, task interest and manifest emotionality. Data are examined in detail.

NYU.08:002

New York U., N. Y.

RANKINGS AND SELF-ASSESSMENTS: SOME BEHAVIORAL CHARACTERISTICS REPLICATION STUDIES, by E. F. Borgatta. [1958] [49]p. incl. tables. (AFOSR-TN-58-737) (AF 49(638)195) AD 162270 Unclassified

Also published in Jour. Social Psychol., v. 52: 279-307, 1960.

Five replications investigate the general nature of behavioral characteristics as they occur in ratings and rankings. Two of the analyses are of the characteristics of persons as perceived in the consensus of group members. These permit a comparison of male and female subjects. A third replication examines the self-ranking which the members make within the context of ranking the total group. The fourth replication involves the ratings, essentially allowing the members an opportunity not only to indicate how they ordered the various qualities, but also to introduce a more abstract frame of reference and the freedom of choosing the level for the ratings. The fifth replication represents the most abstract consideration of the characteristics, being an analysis of the ways the characteristics themselves are judged to belong together. The results suggest that four behavioral characteristics recur fairly consistently: individual assertiveness, sociability, intelligence, and emotionality. The structural arrangement of the characteristics is altered depending on the circumstances of the replication. In terms of judging qualities as compared to characteristics of judging persons, the frame of reference involved appears to be different, but the organization of the other characteristics involved seems to be similar.

NYU.08:003

New York U., N. Y.

THE COINCIDENCE OF SUBTESTS IN FOUR PERSONALITY INVENTORIES, by E. F. Borgatta. Oct. 20, 1958 [22]p. incl. tables. (AFOSR-TN-58-923) (AF 49-(638)195) AD 204557 Unclassified

Also published in Jour. Social Psychol., v. 56: 227-244, 1962.

This paper examines the interrelationship of subtests from four well-known personality inventories that stress subtests with independent content. Two main clusters were found and several minor ones, suggesting construct validity for possibly eight content areas. Problems of subtest meaning, of reliability, and of second order factors are discussed, as well as specific shortcomings of the tests, such as the omission of an emotional stability subtest in the Edwards Personal Preference Schedule. Other limitations may be seen through

NYU.08:004; NYU.02:010, 011;
NYU.04:002; NYU.05:003

comparison as well, such as the fact that if one does not examine male and female data in parallel, it is likely that some subtleties associated with the gross differences in the sexes and which are reflected in the personality structure will be missed. Indeed, one of the ways of establishing the power of a set of subtests is to indicate that they maintain their structure across such grossly different categories as male and female. While the limitations of the tests should be recognized, however, it needs to be stressed in closing that the status of these tests, while improvable, is far from primitive and reflects a tremendous accumulation of experience. (Contractor's abstract)

NYU.08:004

New York U., N. Y.

MOOD, PERSONALITY, AND INTERACTION, by E. F. Borgatta. [1958] [44]p. incl. tables. (AFOSR-TN-58-978) (AF 49(638)195) AD 205855 Unclassified

Mood was studied by means of a checklist which consisted of 40 items that were drawn from a questionnaire utilized by Nowlis at the University of Rochester in 1957. The short adjective checklist was administered before and after a 2½ hr session spent completing questionnaires of various types. The two sets of checklist responses for 180 male college subjects were factor analyzed by the complete centroid method, and rotation was done by quartimax. Six factors were found which were sufficiently well defined to warrant construction of scores to represent the factors. These were: lonely, warmhearted, tired, thoughtful, defiant, and startled. Six scores were constructed on 2 to 4 items each as follows: (1) lonely, insecure, frustrated and fearful; (2) affectionate, forgiving, kindly, and warmhearted; (3) drowsy, tired, and sluggish; (4) serious, engaged in thought, concentrating, and earnest; (5) defiant and rebellious; and (6) startled and shocked. Examination of the male data revealed that, both for the before-and-after-tests mood, lonely correlates with moods 5 and 6 (defiant and startled), and moods 5 and 6 are also positively correlated. Mood 3 (tired) is positively correlated and mood 4 (thoughtful) is negatively correlated with moods 1, 5, and 6, but mood 2 (warmhearted) appears to be clearly independent in the matrix for male data. Data obtained from 35 females tended to show a similar structure with several specific variations. (ASTIA abstract)

NYU. 02:010

New York U. Coll. of Engineering, N. Y.

LOW FREQUENCY ABSORPTION PROJECT, by Y. Beers. Final rept. Nov. 18, 1957, 3p. incl. refs. (Rept. no. 289.9) (AFOSR-TR-57-90) (AF 18(600)968) AD 136724 Unclassified

This report contains a summary of work at New York U. on molecular absorption spectra in the region below 6000 mc/sec.

NYU.02:011

New York U. [Coll. of Engineering] N. Y.

POSSIBLE MOLECULAR AND ATOMIC FREQUENCY STANDARDS IN THE REGION BELOW 2000 Mc/Sec, by Y. Beers. Aug. 22, 1957, 14p. incl. tables. (AF 18-(600)968; continued by AF 49(638)259) Unclassified

This report contains a survey of the various possible methods and spectral lines of gases which might be used for frequency standards in the uhf and vhf regions with special emphasis upon the region of 500 mc/sec. Its principal conclusion is that it should be possible to build a standard based upon the $5_2 - 5_3$ line of HDO at 487 mc/sec within one second, a rms deviation in relative frequency of 2.7×10^{-10} . (Contractor's abstract)

NYU.04:002

New York U. [Coll. of Engineering] N. Y.

[RESEARCH IN THE FIELD OF RADIATION DETECTION EQUIPMENT, SPECIFICALLY COUNTERS], by S. A. Korff. Nov. 1, 1957, 2p. (AFOSR-TR-57-93) (AF 18-(600)1460; continued by AF 18(600)1555) AD 136735 Unclassified

The 2 main areas investigated under this contract were: (1) negative ion effects in halogen-quenched counters; and (2) the radius effect in counters. Using pulsed x-rays, it was found that time lags are probably due, not to negative ions, but to the relatively long period required for halogen molecules to deexcite the metastable atoms formed in the discharge. In studying radius effect a series of counters of different radii was constructed and their counting rate curves were measured as a function of gas pressure. Changing the electric field distribution affected the results very little, but purification of the gas reduced the effect markedly.

NYU.05:003

New York U. Coll. of Engineering, N. Y.

THE PHYSICAL PROPERTIES OF SEVERAL MATERIALS FOR USE IN PHOTO-THERMOELASTIC INVESTIGATIONS, by H. Trampusch and G. Gerard. May 1957, 1v. incl. illus. diagrs. tables. (Technical rept. no. SM 57-5) (AFOSR-TN-57-282) (AF 18(600)1471) AD 132353 Unclassified

Presented at West Coast Conf. of Appl. Mech. Div.,

Presented at annual meeting of the Amer. Soc. Mech. Engineers, Atlantic City, N. J., Nov. 29-Dec. 4, 1959.

Also published in Jour. Appl. Mech., v. 27: 79-86, Mar. 1960.

The photo-thermoelastic method was applied to the experimental evaluation of thermal stress theories. The new technique was correlated with several theories which analyzed the transient thermal stresses in wing structures of high-speed aircraft. Three of the simplest theories were investigated. They all represented the same idealized wing models and differed from each other only in the simplifying assumptions regarding the temperature distributions in skin and stiffeners. The theories were evaluated by duplicating the boundary and initial conditions on plastic models and then by correlating the theories with the observed fringe orders in non-dimensional form. The photo-thermoelastic investigations were concluded with the evaluation of a fourth theory which was identical with the others as far as the boundary and initial conditions were concerned, but much more complicated in its geometrical configuration. It represented a scale model of an actual skin-stiffener combination of a high-speed aircraft which was duplicated in plastic and investigated by the photo-thermoelastic technique. A significant general conclusion was reached after correlating the available theories and experimental results. Due to simplifying assumptions concerning the thermal behavior in the flanges, thermal stresses predicted by the available theories are all higher than the experimental observation. In some cases the discrepancy is as great as 30%. (Contractor's abstract, modified)

NYU 5:006

New York U. Coll. of Engineering, N. Y.

PHOTOTHERMOELASTIC INVESTIGATION OF TRANSIENT THERMAL STRESSES IN A MULTITWEB WING STRUCTURE, by G. Gerard and H. Trampusch. [Nov. 1958] [4]p. incl. illus. diagrs. [Technical rept. no. SM 58-9] (AFOSR-TN-58-1094) (AF 18(600)1471)

Also published in Jour. Aero/Space Sciences, v. 26:
783-786, Dec. 1959.

Photothermoelastic experiments were performed on a long multiweb wing model for which a theoretical analysis is available in the literature. The experimental procedures utilized to simulate the conditions prescribed in the theory are fully described. Correlation of theory and experiment in terms of dimensionless temperature, stress, time, and Biot Number revealed that the theory predicted values higher than the experimentally observed maximum thermal stresses at the center of the web. Detailed temperature measurements in the flange

CORRELATION OF THEORETICAL AND PHOTO-THERMOELASTIC RESULTS ON THERMAL STRESSES IN IDEALIZED WING STRUCTURES, by H. Tramposch and G. Gerard. July 1958 [39]p. incl. illus. diagrs. (Technical rept. no. SM 58-5) (AFOSR-TN-58-621) (AF 18(600)(1471) AD 162150) Unclassified

NYU.05:007, 008; NYU.09:001-003

suggested that the major source of this discrepancy can be traced to the one-dimensional heat conduction analysis of the flange employed in the theory. (Contractor's abstract)

NYU.05:007

New York U. Coll. of Engineering, N. Y.

INVESTIGATION OF THERMAL STRESSES IN AIRCRAFT STRUCTURES BY PHOTOELASTIC TECHNIQUES, by G. Gerard. Final rept. June 1, 1955-May 31, 1958. June 1958, 4p. (AFOSR-TR-58-159) (AF 18-(600)1471) AD 222528 Unclassified

In rather broad aspects, the major accomplishments on this contract have been the establishment of the photothermoelastic technique as a new, rather powerful tool for the analysis of thermal stresses. Immediate fields of application are in aircraft and missile structures as well as nuclear reactor components. A list of reports and published papers produced under the contract are included.

NYU.05:008

New York U. Coll. of Engineering, N. Y.

A RAPID SCANNING SYSTEM FOR RECORDING THERMOCOUPLE OUTPUTS, by H. Trampusch, R. Papirno, and G. Gerard. Mar. 1958 [11p. incl. illus. diagrs. (Technical rept. no. SM 58-3) (AF 18(600)1471) Unclassified

A method for the measurement and recording of the transient temperatures at a large number of locations within a body is described. The temperatures are sensed by thermocouples which are connected to a switching unit and a single cathode ray oscilloscope. The thermocouple voltages appear as a dot array on the oscilloscope screen that is photographed to give a record of the temperature distribution as a function of time and location. The described system is adaptable to measurements other than temperature providing the desired parameter can be transduced to an analogue voltage. In this category would be included strain, velocity, pressure, acceleration and others. (Contractor's abstract)

NYU.09:001

New York U. [Coll. of Engineering] N. Y.

RECENT STUDIES OF COUNTERS, by S. A. Korff. [1957] [4p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1555; continuation AF 18(600)1460] Office of Naval Research, and Atomic Energy Commission) Unclassified

Published in Proc. Third Internat'l. Congress on Ionization Phenomena in Gases, Venice (Italy), (June 11-15, 1957), Milan, 1957, p. 558-561.

The results of investigations on time lags and non-flat plateaus of halogen-quenched counters, the ultraviolet spectrum of BF_3 , and the "radius effect" in BF_3 counters

are reported. In the study of halogen-quenched counters it was found that the time lag depends on overvoltage and the filling gases. Analysis of the discharge mechanism suggested that the lags were caused by the comparatively long time needed for the metastable states formed in the buildup of the avalanche to become deexcited. The plateau slope is dependent on the halogen concentration. Increasing the halogen concentration decreases the time lag, but increases the plateau slope. The investigation of the ultraviolet absorption spectra of BF_3 showed

strong absorption in the regions of 2700 to 2515 and 2300 to 1215 Å. The "radius effect" is that it appears to be difficult to produce large diameter counter with good plateaus but it is easy to make good ones of small diameter. Preliminary work on this problem shows that the radius effect is not caused by a simple effect such as negative ion effects, and the phenomenon is not an end effect. The limiting radius was found to be 2.5 cm.

NYU.09:002

New York U. Coll. of Engineering, N. Y.

RADIUS EFFECT IN BORON TRIFLUORIDE COUNTERS, by R. M. Chang. Dec. 1957, 1v. incl. illus. diagrs. refs. (AFOSR-TN-58-139) (AF 18(600)1555) AD 152166 Unclassified

The radius effect in boron trifluoride counters is defined as the progressive diminution of the flatness of the plateau as the radius of the counter is increased. This report concerns itself with a set of systematic tests of this effect. First, by using ordinary BF_3 it is shown at what radius the effect sets in. Second, by careful purification, it is shown that the effect can be reduced. However, it was not reduced to zero. Third, the possibility that the effect is due to field distortion inside the counter is critically examined, tested, and shown not to be the principal factor. Finally, in the discussion, the directions for future research are indicated. (Contractor's abstract)

NYU.09:003

New York U. [Coll. of Engineering] N. Y.

COSMIC RAY NEUTRON STUDIES, by S. A. Korff. [1958] [5p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)1555] Office of Naval Research, and Atomic Energy Commission) Unclassified

NYU.10:001-003; NYU.11:001, 002

Presented at Internat'l. Convention on Cosmic Rays, Varenna (Italy), June 21-26, 1957.

Published in Nuovo Cimento, Series X, Suppl., v. 8: 796-800, 1958.

The results of IGY neutron monitoring of fluctuations in the number of events at College, Alaska are presented. The mechanisms of neutron production and loss in the upper atmosphere and the general question of the neutron balance are discussed.

NYU.10:001

New York U. [Coll. of Engineering] N. Y.

A USEFUL METHOD FOR INTEGRATING THE TIME-DEPENDENT, VISCOUS EQUATIONS OF MOTION, by L. Filler, H. F. Ludloff and P. Treuenfels. [1957] [1]p. (Sponsored jointly by [Air Force] Office of Scientific Research under [AF 18(603)25] and Office of Naval Research) Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 147, Jan. 1957.

As a preliminary to numerical integration of the three time-dependent, viscous equations of motion, it is instructive to study the "Burger equation," which contains both characteristic features of the motion of a real fluid—viz., the nonlinear as well as the viscosity effects. The most interesting difference procedure to be used for integrating this parabolic differential equation (as well as the true equations of motion) is an implicit scheme, in which the time steps may be taken arbitrarily large. The authors have carried out an analysis of stability and of convergence of iterations before carrying out the numerical integration and comparing it with an analytic solution.

NYU.10:002

New York U. [Coll. of Engineering] N. Y.

ATTEMPTS AT DERIVATION OF TRANSITION FROM LAMINAR INTO TURBULENT FLOW ALONG A FLAT PLATE, by H. F. Ludloff and F. Reiche. Dec. 1957 [13]p. (Rept. no. 2) (AFOSR-TN-58-492) (AF 18-603)25) AD 238162 Unclassified

The equations and procedures employed in this research are discussed. In first approaching this work, the complete Navier-Stokes equations were used. The work carried through concerning stability analysis and the convergence-of-iteration analysis is described.

NYU.10:003

New York U. Coll. of Engineering, N. Y.

ATTEMPTS AT DERIVATION OF TRANSITION FROM LAMINAR INTO TURBULENT FLOW ALONG A FLAT PLATE, by H. F. Ludloff and F. Reiche. June 1958, 21p. incl. diagr. table. (Rept. no. 3) (AFOSR-TN-58-493) (AF 18(603)25) AD 238163 Unclassified

A review of the magnitude of the flow parameters to be expected has shown that the orders of magnitude assumed in the convergence of iterations—proof have to be changed, and as a consequence, the convergence proof had to be altered. In this connection, it was also possible to improve the rate of convergence of successive iterations, by adopting a novel scheme. The analytic problem, consisting of the difference equations of motion, the boundary and initial conditions, was re-formulated. The convergence of iterations of the new procedure was proven, the convergence mechanism was further elucidated by considering the one-dimensional case of the Burgers equation. The computation of the initial field is described. Finally, two important general features of the solution method are exposed: (1) the limitations due to the finite mesh width of the difference scheme, which cuts off the high frequencies of the turbulence spectrum, and (2) the fact that the theory is developed for given, constant Re-number, while the experiments of Schubauer produce conditions, in which the Re-number varies with time. Both difficulties could be satisfactorily resolved. (Contractor's abstract, modified)

NYU.11:001

New York U. Coll. of Engineering, N. Y.

THE ENGINEERING BIOTECHNOLOGY OF HANDLING WASTES RESULTING FROM A CLOSED ECOLOGICAL SYSTEM. THE CULTURE OF ALGAE, by G. P. Edwards. Progress rept. June 1957, 24p. refs. (AFOSR-TN-57-378) (AF 18(603)71) AD 132452 Unclassified

Consideration is given to the mechanics of photosynthesis, nutritional requirements for the growth of algae, mass culture systems, harvesting of algae, contamination of cultures, sewage treatment, types of algae used, inhibiting excretions during growth, the use of algae for food, a photosynthetic gas exchange for the respiratory requirements of humans in a sealed cabin, and the desirable characteristics of algae.

NYU.11:002

New York U. Coll. of Engineering, N. Y.

THE ENGINEERING BIOTECHNOLOGY OF HANDLING WASTES RESULTING FROM A CLOSED ECOLOGICAL SYSTEM. STUDY OF METHODS FOR OBTAINING OXYGEN FROM CARBON DIOXIDE, by H. J. Masson.

NYU.11:003 - NYU.11:006

Progress rept. June 1957, 15p. refs. (AFOSR-TN-57-379) (AF 18(603)71) AD 132453 Unclassified

A means is being investigated for treating CO_2 to recover the O and convert C to a useful form or compound. One of the most important reactions in nature is $\text{CO}_2 + \text{H}_2\text{O} \xrightarrow{\text{catalyst}} (\text{C}_6\text{H}_{10}\text{O}_5)_n + \text{O}_2 + \text{Q}$; chlorophyll is the catalyst in plants. Consideration is given to artificial photosynthesis, the decomposition of CO_2 to provide O, and the reactions of CO_2 with other substances.

NYU.11:003

New York U. Coll. of Engineering, N. Y.

ORIENTATION OF RESEARCH NEEDS ASSOCIATED WITH ENVIRONMENT OF CLOSED SPACES, by W. T. Ingram. [1958] [21]p. incl. tables, refs. (AFOSR-TN-58-106) (AF 18(603)71) AD 152015 Unclassified

Also published in Proc. Fourth annual meeting of the Amer. Astronaut. Soc., New York (Jan. 29-31, 1958), N. Y., Amer. Astronaut. Soc., 1958, p. 17-1-17-18.

A study of several aspects of the environment of closed space has provided a basis for orientation of research needs in coping with the requirements of a healthful, safe, working space under a closed ecology. A discussion is offered of present knowledge and work on such essentials as CO_2 - O_2 conversion, treatment of bodily wastes, recovery of usable water from contained air, urine, and other sources, removal of pollutants from contained air, and purification or disposal of various liquid wastes. The problems of closed-space ecology may be divided into those occurring during extra-terrestrial flight (1) of short duration amounting to hours, (2) of intermediate duration, amounting to days, and (3) of long term, amounting to weeks and months. This discussion deals almost entirely with the third problem, but the orientation of research needs emphasizes that careful study should be made of factors affecting weight and volume of equipment required to process and maintain an environment with total conservation of mass balance and recycle of matter, as opposed to the principle of replacement of essentials such as oxygen and water by withdrawal from storage while polluted matter is ejected from the closed system environment. For conditions introduced by flight of short or intermediate duration, engineering economics may justify provision for partial or even total replacement of environmental constituents. Long-term operations seem impractical without plans for cyclic use of the contained matter. Re-use of contained matter demands positive mechanical, chemical, or biological action that has no chance of failure, since the closed environment will be totally dependent on the continuous and proper functioning of reclamation and conversion operations. (Contractor's abstract)

NYU.11:004

New York U. Coll. of Engineering, N. Y.

THE ENGINEERING BIOTECHNOLOGY OF HANDLING WASTES RESULTING FROM A CLOSED ECOLOGICAL SYSTEM. THERMAL ENERGY EXCHANGE WITH SPECIFIC APPLICATION TO WASTE HANDLING IN A CLOSED ECOLOGICAL SYSTEM, by L. Slote. Progress rept. July 1957, 7p. (AFOSR-TN-58-268) (AF 18(603)-71) AD 154169; PB 137795 Unclassified

The analysis attempts to show the variation in the total surface temperature of a perfect heat conducting or spinning biosatellite for a given orbit and for various conditions of irradiation. As the thermal capacity of the satellite is reduced a temperature distribution is obtained about the surface of the sphere. Therefore, it becomes evident that various temperatures can be obtained depending upon the geometry, surface and trajectory of the biosatellite. With this in mind, it seems feasible to use thermal energy sources in connection with processes for cracking of human waste and for the purification of urine by freezing, if these processes are used.

NYU.11:005

New York U. Coll. of Engineering, N. Y.

THE ENGINEERING BIOTECHNOLOGY OF HANDLING WASTES RESULTING FROM A CLOSED ECOLOGICAL SYSTEM. HANDLING AIR CONTAMINANTS RESULTING FROM A CLOSED ECOLOGICAL SYSTEM, by G. Palevsky. July 1957, 14p. incl. refs. (AFOSR-TN-58-269) (AF 18(603)71) AD 154170; PB 137797

Unclassified

A review of the literature on air contaminants in closed systems is given. Problems associated with the control of temperature, humidity, air motion, foreign matter, microorganisms and the balancing of the CO_2 - O_2 ratio are discussed. Some methods of dealing with these problems are suggested.

NYU.11:006

New York U. Coll. of Engineering, N. Y.

THE ENGINEERING BIOTECHNOLOGY OF HANDLING WASTES RESULTING FROM A CLOSED ECOLOGICAL SYSTEM. SKIN EXCRETIONS, by W. T. Ingram. Oct. 1957, 8p. (AFOSR-TN-58-270) (AF 18(603)71) AD 154171

Unclassified

A review is presented of the chemical composition of sweat (S. Robinson and A. H. Robinson. Physiol. Rev., v. 34: 202-220, 1954). Sweat glands release many electrolytes, organic acids and compounds, and inorganic salts in minute quantities. Sebaceous gland secretions

NYU.11:007; NYU.12:001;
NYU.06:023, 024

are mixed with sweat. The fatty, oily material contains in small quantities cholesterol, some of the simpler fatty acids, fatty acid esters, albumins, and inorganic salts. The aim of this review is to classify and suggest means of dealing with the waste products present in skin excretions.

NYU.11:007

New York U. Coll. of Engineering, N. Y.

THE ENGINEERING BIOTECHNOLOGY OF HANDLING WASTES RESULTING FROM A CLOSED ECOLOGICAL SYSTEM, by W. T. Ingram. Feb. 1958, 221p. incl. refs. (AFOSR-TR-58-148) (AF 18(603)71) AD 162277; PB 143122 Unclassified

This report is directed to an examination of the status of existing information and the areas of research requiring attention in connection with the handling of wastes resulting from human occupancy of a closed ecological system. Probable wastes to be handled are classified. The problems related to handling and treatment and to cycling and reuse of treated end products in liquid, solid, and gaseous form are discussed. Five detailed reports discussing the present status of knowledge of wastes handling in closed systems are included as appendices. Areas of research and development are suggested with respect to skin excretions, algae, culture, carbon dioxide conversion to oxygen, the handling of closed space air, and the handling of bodily and other wastes. A master file of 174 annotated references and an alphabetical author index to those references are included. (The 5 detailed repts. included in the appendices are also published separately, see item nos. NYU.11:001, 002, 004-006)

NYU.12:001

New York U. Dept. of Chemistry, N. Y.

REACTION KINETICS, THERMODYNAMICS, AND TRANSPORT IN THE HYDROGEN-BROMINE SYSTEM. A SURVEY OF PROPERTIES FOR FLAME STUDIES, by E. S. Campbell and R. M. Fristrom. 1957 [62]p. incl. diagrs. tables, refs. (AFOSR-TN-57-675) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)169 and Bureau of Ordnance under NOrd-7386 and NOrd-15884) AD 136665 Unclassified

Also published in Chem. Rev., v. 58: 173-234, Apr. 1958.

Flame theory and experimental techniques have advanced to the point where direct comparison of theory and experiment should be possible. This review was undertaken to aid these studies by collecting and evaluating the information required for a detailed theoretical analysis

of the hydrogen-flame. Included are 83 domestic and foreign references covering open and published literature during a time period from 1871 to 1957.

NYU.06:023

New York U. Inst. of Mathematical Sciences, N. Y.

THE ASYMPTOTIC THEORY OF SOLUTIONS OF

$\Delta u + k^2 u = 0$, by W. L. Miranker. Apr. 1957, 48p. incl. refs. (Research rept. no. BR-21) (AFOSR-TN-57-130) (AF 18(600)367; continued by AF 49(638)229) AD 120486; PB 126039 Unclassified

Part I also published in Jour. Math. and Mech., v. 6: 847-858, Nov. 1957.

Part II also published in Communications in Pure and Appl. Math., v. 10: 491-502, Nov. 1957.

Part III also published in Ann. Math., v. 67: 72, 1958.

Part IV also published in Archiv. Rational Mech. and Analysis, v. 1: 139-153, 1957.

The subject of this report is the asymptotic theory of solutions, u , of the reduced wave equation, $\Delta u + k^2 u = 0$, defined in infinite domains. In Part 1, new proofs are furnished of three well-known theorems concerning u . These are Rellich's growth estimate, the uniqueness theorem for the exterior boundary-value problem, and the representation theorem. A new result, the representation theorem for u when the boundary of the domain of definition of u is infinite, is also given. In Part 2, Rellich's growth estimate is extended to solutions of the equation $\Delta v + k^2(x)v = 0$. From this result it was possible to deduce various uniqueness and representation theorems for solutions of this equation. In Part 3, it is shown that the normal boundary values of a radiating solution, u , of $\Delta u + k^2 u = 0$ is bounded by a homogeneous quadratic functional of its boundary values. This result combined with the representation theorem for u yields an L^2 -maximum principle for u . Finally, in Part 4, the behavior of u when the parameter k becomes large is considered. The method of G. Birkhoff is explained for obtaining formal asymptotic expansions for u , and deduce several results concerning the existence and validity of these formal expansions. (Contractor's abstract)

NYU.06:024

New York U. Inst. of Mathematical Sciences, N. Y.

HILLS EQUATION. PART I. GENERAL THEORY, by W. Magnus and A. Shenitzer. June 1957, 42p. (Research rept. no. BR-22) (AFOSR-TN-57-291) (AF 18(600)367) AD 132362 Unclassified

NYU.06:025-027; NYU.13:001

A detailed account is presented of the elements of the theory of Hill's equation, and a brief review is given of the results and applications which have been made. The elementary parts of the theory are developed, and complete proofs of all results are given. The review of results provides a guide to literature on special cases and their applications to mechanical and electrical problems.

NYU.06:025

New York U. Inst. of Mathematical Sciences, N. Y.

EXPANSIONS FOR PRODUCTS OF TWO WHITTAKER FUNCTIONS, by F. M. Ragab. July 1957, 13p. (Research rept. no. BR-23) (AFOSR-TN-57-419) (AF 18(600)367) AD 132498 Unclassified

Whittaker functions and E-functions are expanded in terms of products of these functions. Also, products of two Whittaker functions or two E-functions are expanded, in series involving these functions. The variable is the same in all terms of the series and the values of the parameters differ by integers. (Contractor's abstract)

NYU.06:026

New York U. Inst. of Mathematical Sciences, N. Y.

SOME FORMULAS FOR THE PRODUCTS OF E-FUNCTIONS AND WHITTAKER FUNCTIONS, by F. M. Ragab. Sept. 1957, 8p. (Research rept. no. BR-24) (AFOSR-TN-57-582) (AF 18(600)367) AD 136570 Unclassified

The following integral, which is a product of Whittaker functions

$$\int_0^\infty \exp\left[\frac{1}{2}\left(x + \frac{b}{x}\right)\right] W_{k,m}\left(\frac{b}{x}\right) dx =$$

$$\frac{\pi^{\frac{1}{2}} \Gamma(-k+m) \Gamma(-k-m)}{\Gamma(\frac{1}{2}-k+m) \Gamma(\frac{1}{2}-k-m)} \cdot \frac{b^{-\frac{1}{2}}}{2^{\frac{1}{2}k+\frac{1}{2}m}} e^{\sqrt{b}} W_{2k+\frac{1}{2}, 2m}(2\sqrt{b}),$$

is generalized in terms of another Whittaker function, which is deduced as a particular case from the formula for MacRobert's E-function. Proof is established for this multiple integral by showing the product of the E-functions is essentially an E-function.

NYU.06:027

New York U. Inst. of Mathematical Sciences, N. Y.

BASIC MATHEMATICAL RESEARCH FOR ELECTROMAGNETIC THEORY, by M. Kline. June 15, 1952-June 14, 1958 [17]p. incl. refs. (Research rept. no. BR-25) (AFOSR-TR-58-80) (AF 18(600)367) AD 158369; PB 138985 Unclassified

Mathematical tools in the fields of ordinary and partial differential equations, integral equations, special functions, and asymptotic series solutions of electromagnetic problems are investigated. A determinant of infinite order which arises when a solution of Mathieu's equation is expressed in the form $y = \sum_{n=-\infty}^{\infty} c_n \exp(i2nx)$ is considered.

The relationship between Hill's determinant and the values of the solutions is shown (item no. NYU.06:001; item no. NYU.06:024). Conditions are stated under which general operators L occurring in equations such as $Lx = a$ possess the property of having a closed range in the Hilbert space (item no. NYU.06:018). On the assumption that the atmosphere is horizontally stratified so that the dielectric tensor varies in one direction only, Maxwell's equations applied to this anisotropic medium can be reduced to a system of 4 first-order linear ordinary differential equations in which 4 of the 6 components of E and H are the dependent variables (item no. NYU.06:003; item no. NYU.06:012). Portions of the theory of partial differential equations which have a bearing on electromagnetic problems are studied (item no. NYU.06:002; item no. NYU.06:013; item no. NYU.06:014). New methods of solving the Wiener, Hopf, and Fredholm integral equations are considered (item no. NYU.06:015; item no. NYU.06:017; item no. NYU.06:022). Addition theorems for Bessel and Legendre functions, spherical harmonics, Mathieu functions and other special functions are considered, and are adapted to a particular transformation of coordinates (item no. NYU.06:020; item no. NYU.06:021). Special functions called Whittaker functions and E-functions are expanded (item no. NYU.06:025; item no. NYU.06:026). Asymptotic series solutions of Maxwell's equations are presented (item no. NYU.06:009; item no. NYU.06:016; item no. NYU.06:023).

NYU.13:001

New York U. Inst. of Mathematical Sciences, N. Y.

DETERMINATION OF BUCKLING CRITERIA BY MINIMIZATION OF TOTAL ENERGY, by S. Lubkin. July 1957, 60p. incl. diagrs. (Rept. no. IMM-NYU 241) (AFOSR-TN-57-579) (AF 49(638)161) AD 136567 Unclassified

With the assumption of constancy of the elastic constants in Hooke's Law over the range of strains involved, but no limitation upon magnitude of strains or displacements, formulae for strain energy are derived for several cases of interest. Exact buckling criteria are derived from the effect of small perturbations, from displacements in an unbuckled state, upon the total energy. This method is applied to (1) a column of rectangular section, compressed so as to keep its end flat and parallel to their original position; (2) a hollow circular cylinder, subjected to uniform pressure on its outer surface; and (3) a hollow sphere, subjected to uniform external pressure. In all cases, for thin sections, results agree with those derived by other means. It is shown that with the given

NYU.13:002; NYU.14:001, 002;
NYU.15:001

assumption, a buckling or critical load always exists, no matter what the geometric proportions. As an interesting sidelight, it is also shown that a finite pressure may expand the cylinder or sphere to infinity. (Contractor's abstract)

NYU.13:002

New York U. Inst. of Mathematical Sciences, N. Y.

ON FINITE DEFORMATIONS OF AN ELASTIC ISOTROPIC MATERIAL, by F. John. Oct. 1958 [88]p. incl. diagrs. (Rept. no. IMM-NYU 250) (AFOSR-TN-58-955) (AF 49(638)181) AD 205348; PB 138255
Unclassified

Finite deformations of ideal elastic materials are mathematically analyzed. A geometric analysis, independent of the physical properties of materials, was made for the case of a square plate of side a and thickness h , where $h \leq a$. Analysis of the equation

$|f(x) - g(x)| \leq M\epsilon a^2/h$ shows that a deformation of a plate differs from a rigid motion by a quantity of order ϵa , unless the thickness h of the plate is small in comparison to its width a . For thin plates the components of displacement tangential to the plate stay of order ϵa while the normal components can be of order $\epsilon a^2/h$. The amount is measured by which the transformation f differs from a rigid motion g by the maximum of $f - g$. An exposition is given of the classical equations for ideal elastic isotropic materials. Stress-strain relations and changes in potential energy resulting from changes in the transformation $x' = f(x)$ are analyzed. Equations are derived for bending of thin plates using Lagrange coordinates. The complete system of differential equations for the first non-vanishing quantities constitutes what may be considered as the differential equations for thin plates. Differential equations for the lowest order non-vanishing quantities are found to involve only 2 material constants, the Lamé constants λ and μ . (ASTIA abstract)

NYU.14:001

New York U. Inst. of Mathematical Sciences, N. Y.

THE COEXISTENCE PROBLEM FOR HILL'S EQUATION, by S. Winkler and W. Magnus. July 1958, 91p. incl. diagrs. refs. (Research rept. no. BR-26) (AFOSR-TN-58-660) (AF 49(638)229) AD 182191
Unclassified

Hill's equation with a periodic coefficient of period π is investigated. The problem of the coexistence of two linearly independent solutions with period π or 2π is considered, and all known cases in which such a coexistence occurs are shown to be special cases of a four-parametric equation which can be transformed into an equation of Hill's type. Also, the question of the

existence of solutions admitting a terminating Fourier expansion is investigated, and partial answers provided. (Contractor's abstract)

NYU.14:002

New York U. Inst. of Mathematical Sciences, N. Y.

TRANSCENDENTAL EQUATIONS IN ELECTROMAGNETIC THEORY, by L. Kotin and W. Magnus. Aug. 1958, 38p. (Research rept. no. BR-27) (AFOSR-TN-58-749) (AF 49(638)229) AD 201501; PB 138062
Unclassified

Also published in *Numerische Mathematik*, v. 2: 228, 1960.

The problem of determining the zeros of the Hankel function $H_\nu^1(x)$ for fixed real x and variable (complex) ν plays a role in propagation theory and in the theory of diffraction by a metallic sphere. The equation $H_\nu^1(x) = 0$ defines ν as a function of x . The qualitative behavior of this function (for $x > 0$) is determined for all $x \geq 1/4$. Complex values of x are also considered. In the case of a sphere of finite conductivity, the corresponding transcendental equation is similarly treated. (Contractor's abstract)

NYU.15:001

New York U. Inst. of Mathematical Sciences, N. Y.

STATISTICAL MECHANICS OF COUPLED PARTICLES IN THE SCHRÖDINGER REPRESENTATION, by R. H. Kraichnan. Aug. 5, 1958 [6]p. incl. diagrs. (AFOSR-TN-58-692) (AF 49(638)341) AD 215307
Unclassified

Also published in *Phys. Rev.*, v. 112: 1058-1057, Nov. 15, 1958.

A perturbation treatment is presented for the operator $u(t)$ giving the evolution of the state vector of a system of N particles coupled by 2-body forces. The total Hamiltonian is divided into a diagonal part H_0 and off-diagonal part H_1 in the representation with N -particle plane-wave states as basis. An effective pair-interaction operator \bar{H}_1 is defined which includes "vertex" corrections of all orders, and the off-diagonal part of u is expressed exactly by an expansion which involves only \bar{H}_1 and the exact diagonal part of u . A closed set of equations determining \bar{H}_1 and the diagonal part of u are obtained by retaining only the leading terms in the expansion. These equations include all the corrections included in the Brueckner approximation and, in addition,

NYU.15:002-004; NYU.07:003

they contain 3-body effects, iterated to all orders, which are omitted in that approximation. No appeal has been made to one-to-one correspondence between the eigenstates of H_0 and those of the total Hamiltonian, and the ground state plays no special role. The connection with statistical mechanics follows since the partition function is $\text{Tr}[u(-i/kT)]$. The theory simplifies greatly for very large N . (Contractor's abstract)

NYU.15:002

New York U. Inst. of Mathematical Sciences, N. Y.

STATISTICAL MECHANICS OF COUPLED BOSONS IN THE HEISENBERG REPRESENTATION, by R. H. Kraichnan. Aug. 5, 1958, 5p. incl. diagrs. (AFOSR-TN-58-693) (AF 49(638)341) AD 215308 Unclassified

Also published in Phys. Rev., v. 112: 1054-1055, Nov. 15, 1958.

A system of bosons interacting by 2-body forces is treated in momentum space in the Heisenberg representation, assuming a statistically homogeneous and stationary state. The principle of weak statistical dependence of different momentum modes, previously applied to turbulence dynamics, is used to obtain an exact expansion expressing quadrilinear (2-body) time-displaced correlation functions of the second-quantized field variables in terms of bilinear time-displaced correlation functions and average impulse-response functions. The last-named functions are defined in terms of the exact Green's operator, for infinitesimal sources, of the nonlinear Heisenberg equations of motion. A set of coupled integral equations are then obtained which determine both the bilinear correlation functions and the response functions. By retaining in these equations only the lowest terms in the cited expansion, a theory is obtained which includes particle "self-energy" interactions with the medium of all orders. A modification of the theory is briefly outlined which includes, at finite temperatures, all the processes described at absolute zero by the Brueckner approximation and, in addition, 3-body effects, iterated to all orders, which are omitted in that approximation. (Contractor's abstract)

NYU.15:003

New York U. Inst. of Mathematical Sciences, N. Y.

HIGHER ORDER INTERACTIONS IN HOMOGENEOUS TURBULENCE THEORY, by R. H. Kraichnan. [1958] [2]p. incl. diagrs. (AF 49(638)341) Unclassified

Published in Phys. Fluids, v. 1: 358-359, July-Aug. 1958.

In an earlier paper by Kraichnan (Phys. Rev., v. 109: 1407-1422, Mar. 1, 1958) a theory of homogeneous

turbulence was developed from the two statistical assumptions of weak-dependence and direct-interaction. Further work is now described which suggests that the second assumption is more properly termed the direct-interaction approximation. It yields the leading nonlinear terms in a pair of coupled integral equations for the time-covariance and impulse-response functions of the Fourier amplitudes of the velocity field. The full equations contain, in addition, sums over higher order contributions. It is conjectured that the direct interaction approximation quite likely is a good one at all Reynolds numbers. The theory is supported by application to a model system for which an exact solution for comparison can be obtained by other means.

NYU.15:004

New York U. Inst. of Mathematical Sciences, N. Y.

STATISTICAL MECHANICS OF MANY-BODY SYSTEMS (Abstract), by R. H. Kraichnan. [1958] [2]p. (Bound with its AFOSR-TR-58-125; AD 162274) (AF 49(638)341) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

This research is concerned with the application to quantum-mechanical and classical many-body problems of new statistical-mechanical methods employed successfully in turbulence theory. These methods are equally valid for equilibrium states, strongly non-equilibrium states, and strongly dissipative states.

NYU.07:003

New York U. Physics Dept., N. Y.

PERSISTENT INTERNAL POLARIZATION, by H. P. Kallmann. Progress rept. no. 6, Vol. i (Annual) Oct. 15, 1955-Oct. 14, 1956. June 1957, 80p. incl. diagrs. tables. (AFOSR-TN-57-371) (AF 18(600)1004) AD 132443 Unclassified

Persistent Internal Polarization (PIP) Effects in Various An-Cd Phosphors: The dark decay and release of polarization of light were experimentally found to obey the following respective laws:

$$\frac{d\sigma(t)}{dt} = -\frac{\bar{K}\sigma(t_0)}{t + \alpha} \approx -\frac{\bar{K}\sigma(t_0)}{t} \quad \text{and} \quad \frac{d\sigma(\tau)}{d\tau} = -\frac{\sigma_0\beta}{(\tau + \beta)^2} = -\frac{\sigma(\tau)^2}{\sigma_0\beta}$$

t represents time after termination of the polarizing process; τ , the light-release time scale; t_0 , the time at

which polarization is first determined either by light release or electrode lifting; K and β are the characteristic constants associated with the dark-decay and light-release processes, respectively; and $\sigma(t)$, $\sigma(t_0)$, $\sigma(\tau)$,

NYU.07:004 - NYU.07:007

and σ_0 represent the charge densities of polarization in a sample during t , t_0 , τ , and when $\tau = 0$, respectively.

Further Development of the Phenomenological Model: The double charge layer model was a good approximation to the type of polarization encountered in K powders. Thickness Effects in Unwaxed K Powders: Proof was obtained that polarization density is nearly independent of field strength but depends only on the polarizing voltage. Thickness Effects in Wax Impregnated Samples: Measurements on K powders indicated that polarization is not of a grain nature. Dilute Powder Suspensions in Different Matrices: The charge transfer from grain to grain and its separation over many grains was studied. Charge Injection in Wax Impregnated Samples: Qualitative measurements were made of the detection of charge injection in waxed K powders. IR Effects in Unwaxed K Powders: A quenched powder can be excited by IR even for wavelengths longer than those used during the quench.

NYU.07:004

New York U. Physics Dept., N. Y.

PERSISTENT INTERNAL POLARIZATION, by H. P. Kallmann. Progress rept. no. 6, Vol. II (Annual) Oct. 15, 1955-Oct. 14, 1956. June 1957, 80p. incl. diagrs. tables. (AFOSR-TN-57-375) (AF 18(600)1004) AD 132449 Unclassified

The Polarization of Single CdS Crystals: Large PIP effects were found in single CdS crystals. These effects could be almost completely masked by the induction of photocurrents unless precautions were taken. Visible radiations as low as 10^{-2} μ w/sq cm nullified the separation of charge almost immediately. IR wavelengths could be used to produce polarization to 2 or 3×10^{-8} coul/sq cm with a 200-v polarizing voltage. This polarization had a persistence of several days. Polarization Process in Anthracene: Anthracene layers of almost single-crystal structure were developed which were suitable for use in investigating the build-up and distribution of the polarization. The internal field distribution in these layers was measured, and information was obtained concerning how the charge set free in anthracene is transferred to adjacent layers.

NYU.07:005

New York U. Physics Dept., N. Y.

A PHOSPHOR MEMORY-PERSISTENT INTERNAL POLARIZATION, by H. [P.] Kallmann and J. Rennert. [1957] [7]p. incl. table. (AF 18(600)1004) Unclassified

It may be seen readily that, with internal polarization

voltages in the order of 10^2 V and charge concentrations of about 10^{-7} coulombs/cm², energies of about 10^2 ergs/cm² can be stored in these materials. Thicknesses of the phosphor layers are tenths mm. It should be noted here that these persistent internal polarization materials are sensitive to radiation of wave lengths as short as fractions of Angstrom units to as far in the infrared as microns. The state of excitation decays only slowly in some materials. In such cases it is actually possible to polarize a sample by applying a voltage to it subsequent to excitation. The broad sensitivity spectrum, the considerable amount of energy which can be stored and the flexibility of the methods for obtaining polarization and releasing it may be exploited in memory devices, electrophotography, dosimetry and infrared work. Some of these practical objectives have already been reduced to practice. (Contractor's abstract)

NYU.07:006

New York U. Physics Dept., N. Y.

PERSISTENT INTERNAL POLARIZATION AND APPLICATIONS, by H. [P.] Kallmann and J. Rennert. [1957] [8]p. incl. diagrs. table. [AF 18(600)1004] Unclassified

Published in Proc. Symposium on The Role of Solid State Phenomena in Electric Circuits, Polytechnic Inst. of Brooklyn, N. Y. (Apr. 23-25, 1957), N. Y., Interscience Publishers, 1957, p. 325-332.

In this survey, practical applications of persistent internal polarization (PIP) in photoconductive materials to memory devices as well as electrophotography with ultraviolet, visible and infrared radiation are discussed. The phenomenon itself which has been known for a long time as an interfering effect in photoconductivity studies has been investigated extensively at New York U. The results of these findings are summarized and the practical applications are described. (Contractor's abstract)

NYU.07:007

New York U. Physics Dept., N. Y.

ELECTRIC FIELD DISTRIBUTION IN POLARIZED PHOTOCONDUCTORS, by H. P. Kallman and J. R. Freeman. [1958] [3]p. incl. diagrs. table. [AF 18(600)-1004] Unclassified

Published in Phys. Rev., v. 109: 1506-1508, Mar. 1, 1958.

Persistent internal polarization is shown to result from the accumulation of trapped charge near the surface layers of a photoconductor. At equilibrium it is predominantly of a bulk nature, rather than being localized in individual grains. The charge layers are found to be

NYU.16:001 - NYU.16:004

restricted to narrow regions from 5 to 10 microns from each surface. This distance is almost independent of sample thickness and polarizing voltage. While the external field is still applied, the equilibrium state of polarization is such that between the layers the field approaches zero. This is concluded from the fact that the buildup and release of polarization proceed at the same rate when equal exciting intensities are used. (Contractor's abstract)

NYU.16:001

New York U. Physics Dept., N. Y.

THEORY OF THE CAVITY MICROWAVE SPECTROMETER AND MOLECULAR FREQUENCY STANDARD, by Y. Beers. Sept. 12, 1958 [18]p. incl. diagr. refs. (AFOSR-TN-58-871) (Sponsored jointly by Air Force Office of Scientific Research under AF 48(638)259; continuation of AF 18(800)968 and Office of Naval Research under Nonr-28535) AD 203714 Unclassified

Also published in Rev. Scient. Instruments, v. 30: 9-16, Jan. 1959.

A short section of a wave guide is considered as a non-resonant absorption cell and then as a resonant cavity. It is shown that the latter gives a better signal-to-noise ratio by a factor which depends upon the relative intensity of the various noise sources but which increases with the Q. It is shown that the voltage signal-to-noise ratio is proportional to the square root of the product of the volume and the Q and otherwise is independent of the shape. This result leads to the conclusion that it is possible in theory to build microwave spectrometers having signal-to-noise ratios some 50 db larger or capable of detecting absorption coefficients some 300 times smaller than spectrometers which are now widely used. However, practical considerations probably would prevent all of this advantage from being realized. These results are applied to a frequency standard using an absorption line. It is shown that it is possible to build a standard using the 3,3 line of NH_3 with a fractional stability of about 4×10^{-12} over an extended interval of time. Some discussion of spectrometers with long non-resonant cells is included also. (Contractor's abstract)

NYU.16:002

New York U. Physics Dept., N. Y.

THE COMPARISON OF WAVE GUIDE AND CAVITY MICROWAVE SPECTROMETERS (Abstract), by Y. Beers. [1958] [1]p. (AF 49(838)259) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 213, May 1, 1958.

A short section of wave guide is considered alternately as a true wave guide absorption cell terminated by its characteristic impedance and as a high Q resonator. With the assumption of a detector which is linear in voltage, which usually is valid, it can be shown that in resonator operation the voltage signal-to-noise ratio is larger by a factor from about $(Q/2)^{1/2}$ to about $Q/2$, depending upon whether or not saturation of the sample is imminent and upon how the noise is divided between the oscillator and detector. If saturation is imminent, the input voltage to the resonator must be smaller by a factor of $Q^{1/2}$, and then a simple crystal video detector may not be adequate. A variety of evidence indicates that a considerable portion of the noise probably comes from the oscillator.

NYU.16:003

New York U. [Physics Dept.] N. Y.

S BAND MICROWAVE SPECTRUM N^{15}O_2 (Abstract), by J. Rosenthal. [1958] [1]p. (AF 49(838)259) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 214, May 1, 1958.

A rotational transition of N^{15}O_2 , predicted by G. R. Bird has been observed in the S band microwave region. Using a Stark-modulated spectrometer, the following multiplet was discovered: (a) 4321, (b) 4243, (c) 4082, (d) 3900, (e) 3759, and (f) 3661 mc/sec. The precision is approximately 1 mc/sec and will be increased in further measurements. It is suggested that the above are magnetic fine structure components for the $8_{08} - 7_{17}$ rotational transition. These data offer further confirmation of a combination rule, arrived at independently by Bird and C. C. Liu. It is seen that the frequency difference of 239 mc/sec between lines (a) and (c) also holds for (d) and (f). A search will be made for the $22_1 - 21_2$, 20 transition.

NYU.18:004

New York U. Physics Dept., N. Y.

GROUND-STATE INVERSION SPECTRUM OF N^{14}D_3 , by G. Herrmann. [1958] [5]p. incl. diagrs. tables, refs. (AF 49(838)259) Unclassified

Published in Jour. Chem. Phys., v. 26: 875-879, Oct. 1958.

The inversion spectrum of N^{14}D_3 has been investigated between 1500 and 1620 mc/sec. A revised formula for

the rotational fine structure was obtained to fit 17 observed lines. Splitting of $K = 3$ lines into two components was found in good agreement with predicted values. Nitrogen satellites were observed and the values $(eQq)_N = 4080 \pm 3$ kc/sec and $a = 2 \pm 2$ kc/sec were assigned to the nitrogen quadrupole and magnetic coupling constants, respectively. Hyperfine structure due to removal of the K degeneracy was observed to $K = 1$ lines. Applying the theory of Hadley, calculated and observed line contours were brought into agreement. Assuming cylindrical symmetry about bonds, the value $(eQq)_D = 200 \pm 20$ kc/sec was obtained for the deuteron quadrupole coupling constant. A value $\epsilon = 1.9 \pm 0.5$ kc/sec was obtained for the magnetic coupling constant between deuteron spins and molecular rotation.

Nobel Inst. for Neurophysiology, Stockholm (Sweden).
see Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

Norman Bridge Lab. of Physics, Pasadena, Calif.
see California Inst. of Tech. Norman Bridge Lab. of
Physics, Pasadena.

NAA.01:007

North American Aviation, Inc., Downey, Calif.

RESEARCH ON STABILITY AND TRANSITION OF THE
LAMINAR BOUNDARY LAYER (Unclassified title), by
E. R. van Driest and W. D. McCauley. Oct. 1, 1956,
22p. incl. illus. (Rept. no. AL-2377) (AFOSR-TN-57-
15) (AF 18(600)786; continued by AF 49(638)250)
AD 115047 Confidential

NAA.02:001

North American Aviation, Inc. Atomics International Div.,
Canoga Park, Calif.

RESEARCH ON ELECTRON ENERGY STATES IN
TRANSITION METALS, by G. W. Lehman and T. G.
Berlincourt. Final rept. Feb. 1, 1956-Feb. 1, 1957
[27]p. incl. diagrs. tables, refs. (Rept. no. AI-1889)
(AFOSR-TR-57-25) (AF 18(600)1575) AD 120499
Unclassified

The energy band structure of hexagonal close packed
titanium has been worked out using a modified Slater-
Koster LCAO approach for the 3d band and an effective
mass approach for the 4s band. The two-center inte-
grals in the LCAO approach for Ti are taken as being
proportional to those for Ni derived by Wohlfarth and

Fletcher. The energy levels at 300 points in the Bri-
llouin zone for the 3d band have been obtained by diag-
onalizing a 10×10 Hermitian matrix with the aid of an
IBM 704 Electronic Digital Computer. (A production pro-
gram for computing the wave functions in the 3d band
has also been completed.) A universal density of states
was constructed from the energy levels. The constant of
proportionality mentioned previously was estimated from
the observed cohesive energy. From this result, it is
found that 3.4 and 0.6 electrons/atom occupy the 3d and
4s bands respectively. A 3d band width of about 3.8 ev
was found. The theoretical electronic specific heat
(valid in the liquid helium temperature range) derived
from the density of states curve at the Fermi level is
about 80% larger than that observed by Smith and
Wolcott. Possible reasons for this discrepancy are
given. Hall effect measurements have been carried out
on pure polycrystalline Ti and Cu between 1.2°K and
room temperature. The Hall coefficient versus temper-
ature curves are characterized in both metals by a weak
temperature dependence in the residual resistivity re-
gion; a strong temperature dependence in the small an-
gle electron-phonon scattering region; and a weak tem-
perature dependence in the linear resistivity region.
Magnetoresistance measurements have been carried
out on pure polycrystalline Ti and on a single crystal
of Ti containing Mn and Al impurity. The former ex-
hibited a very small positive magnetoresistance, while
the latter exhibited a sizeable negative magnetoresist-
ance. Possible interpretations of these results are dis-
cussed, and the experimental apparatus and techniques
are described.

NAA.02:002

North American Aviation, Inc. Atomics International Div.,
Canoga Park, Calif.

SOME ELECTRICAL PROPERTIES OF URANIUM,
TITANIUM, AND COPPER (Abstract), by T. G.
Berlincourt. [1957] [1]p. (Sponsored jointly by [Air
Force Office of Scientific Research under AF 18(600)-
1575] and Atomic Energy Commission) Unclassified

Presented at meeting of Amer. Phys. Soc., Philadelphia,
Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 136,
Mar. 21, 1957.

Hall effect measurements have been carried out on poly-
crystalline uranium, titanium, and copper between 1.2°K
and room temperature. The Hall coefficient vs temper-
ature curves are characterized in all three metals by a
weak temperature dependence in the residual resistiv-
ity region; a strong temperature dependence in the small
angle electron-phonon scattering region; and a weak
temperature dependence in the linear resistivity region.
Such behavior in a simple metal like copper supports
the view that the effect of scattering is comparable to
the effect of charge carrier concentration even in a

NAA.02:003 - NAA.02:006

one-band metal. Values of the Hall coefficient, R_H in units of $\text{cm}^3/\text{coulomb} \times 10^{-5}$, are listed below at three temperatures:

	$R_{4.2^\circ\text{K}}$	$R_{77^\circ\text{K}}$	$R_{300^\circ\text{K}}$
Uranium	1.45	3.9	4.1
Titanium	-4.1	-0.95	-0.05
Copper	-6.8	-6.1	-5.1

The results of low-temperature transverse magnetoresistance measurements on a uranium single crystal for various orientations are also reported. (Contractor's abstract)

NAA.02:003

North American Aviation, Inc. Atomics International Div., Canoga Park, Calif.

SIZE EFFECT IN THE HALL COEFFICIENT OF Cu, AND SUPERCONDUCTIVITY OF METASTABLE U BASE Mo ALLOYS, by T. G. Berlincourt. [1957] [5]p. incl. diagrs. table. (Sponsored jointly by [Air Force Office of Scientific Research under AF 18(600)1575] and Atomic Energy Commission) Unclassified

Published in Proc. Fifth Internat'l. Conf. on Low Temperature Phys. and Chem., Madison, Wis. (Aug. 26-31, 1957), Madison, Univ. of Wisconsin Press, 1958, p. 492-497.

Measurements of the Hall coefficient R of several annealed polycrystalline Cu strips of resistivity ratio $s = \rho(273)/\rho(4.2) \sim 450$ and thicknesses t ranging from 0.05 to 1.6 mm have revealed the existence of a marked size effect at low temperatures. Resistivity and Hall measurements have been performed on metastable γ (b.c.c.) phase U base alloys containing 5, 10, and 15 wt % Mo. The superconducting transitions as observed by resistance measurements were unusually narrow.

NAA.02:004

North American Aviation, Inc. Atomics International Div., Canoga Park, Calif.

RESEARCH ON ELECTRON ENERGY STATES IN TRANSITION METALS, by T. G. Berlincourt, G. W. Lehman, and R. R. Hake. Final rept. May 1, 1957-June 30, 1958. July 31, 1958 [35]p. incl. diagrs. tables, refs. (Rept. no. AI-3051) (AFOSR-TR-58-109) (AF 18(600)1575) AD 201611 Unclassified

Measurements were made on the Hall effect, resistivity, and magnetoresistivity of Cu, Zr, Ti, and Nb at about 1°K and room temperature and in magnetic fields up to 30 kilogauss. Results indicated that the relationship between electron transport properties and electronic

structure is more complicated than is generally appreciated. Anomalous behavior was observed in the Hall effect of Cu in that size effects were evident for sample thicknesses considerably greater than the generally accepted mean free path. Strong temperature dependences were observed in the Hall coefficients of Cu, Ti, and Zr, which suggests that scattering is comparable with charge carrier concentration in determining the Hall coefficient. The Hall coefficients of Zr and Ti were found to be extremely sensitive to impurity content. Comparisons with theory were carried out, and it was concluded that existing theories are not sufficiently general to account quantitatively for the observed temperature and magnetic field dependences of the Hall effect and resistivity. Unusual behavior was observed in the magnetic field induced superconducting transition of Nb. Apparatus was constructed for the measurement of specific heats of metals and alloys in the liquid helium temperature range. (ASTIA abstract)

NAA.02:005

North American Aviation, Inc. Atomics International Div., Canoga Park, Calif.

HALL EFFECT, MAGNETORESISTANCE, AND SIZE EFFECTS IN COPPER, by T. G. Berlincourt. [June 1958] [28]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1575 and Atomic Energy Commission) Unclassified

Also published in Phys. Rev., v. 112: 381-387, Oct. 15, 1958.

Measurements of the Hall coefficient of several annealed polycrystalline Cu strips of resistivity ratio $\rho(273^\circ\text{K})/\rho(4.2^\circ\text{K}) \sim 450$ and thicknesses ranging from 0.05 to 1.6 mm have revealed the existence of a marked size effect at low temperatures. The effect is orders of magnitude greater than that to be expected on the basis of free electron theory. It is suggested that earlier low-temperature data on the Hall effect of thin high-purity samples are subject to uncertainties arising from such effects. Size effects were also evident in the transverse magnetoresistance. At high fields, a tendency toward saturation in the transverse magnetoresistance was observed for thick samples. The temperature dependence of the Hall coefficient has also been studied. (Contractor's abstract)

NAA.02:006

North American Aviation Inc. Atomics International Div., Canoga Park, Calif.

HALL EFFECT, RESISTIVITY, AND MAGNETORESISTIVITY OF Th, U, Zr, Ti, AND Nb, by T. G. Berlincourt. [Dec. 1958] [35]p. incl. diagrs. tables,

NAA.03:001 - NAA.03:004

refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1575 and Atomic Energy Commission) Unclassified

Also published in Phys. Rev., v. 114: 969-977, May 15, 1959.

The Hall effect, resistivity, and magnetoresistivity of Th, U, Zr, Ti, and Nb have been studied at temperatures between $\sim 1^\circ\text{K}$ and room temperature and in magnetic fields up to 30 kilogauss. Strong temperature and purity dependences were observed in the Hall coefficients of U, Ti, and Zr. In addition, the Hall coefficient of Zr was strongly dependent upon magnetic field strength at liquid helium temperatures. Comparisons with theory have been carried out, and it is concluded that existing theories are not sufficiently general to account quantitatively for the observed temperature and magnetic field dependences of the Hall effect and resistivity. Unusual behavior was observed in the magnetic-field-induced superconducting transition of Nb. (Contractor's abstract)

NAA.03:001

North American Aviation, Inc. Missile Development Div., Downey, Calif.

ON MASS TRANSFER NEAR THE STAGNATION POINT, by E. R. van Driest. June 1, 1957, 20p. incl. diagrs. (Rept. no. AL-2553) (AFOSR-TN-57-458) (AF 49(638)-250; continuation of AF 18(600)786) AD 136449

Unclassified

Heat transfer with blowing near the stagnation point is computed by first analyzing the problem for the flat plate without pressure gradient and then converting the solution to that for the stagnation region of spheres and cylinders. (Contractor's abstract)

NAA.03:002

North American Aviation, Inc. Missile Development Div. [Downey, Calif.]

ON THE AERODYNAMIC HEATING OF BLUNT BODIES, by E. R. van Driest. Nov. 1, 1957, 31p. incl. diagrs. refs. (Rept. no. MD 58-8) (AFOSR-TN-57-732) (AF 49(638)250) AD 136716

Unclassified

Published in Zeitschr. Angew. Math. Phys., v. 9B: 233-248, 1958.

Calculation of the heating rate for blunt bodies in high-speed flight, including the phenomenon of transition, is discussed. Analysis of the problem with transpiration cooling is presented. (Contractor's abstract)

NAA.03:003

North American Aviation, Inc. Missile Development Div., Downey, Calif.

BOUNDARY-LAYER TRANSITION ON A 10° CONE AT MACH NUMBER 2.81 AS AFFECTED BY EXTREME COOLING, by E. R. van Driest and W. D. McCauley. [1957] [2]p. incl. illus. [AF 49(638)250] Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 780-781, Oct. 1957.

Experiments conducted do not show a reversal in transition Reynolds numbers with large amounts of cooling, contrary to the results obtained by (N. S. Diaconis, J. P. Jack, and R. J. Wisniewski, Boundary-Layer Transition at Mach 3.12 as Affected by Cooling and Nose Blunting, NACA TN 3928, Jan. 1957). Rather it appears that a delay in transition may still be accomplished at very low temperature ratios.

NAA.03:004

North American Aviation, Inc. Missile [Development] Div. [Downey, Calif.]

THE EFFECT OF CONTROLLED THREE-DIMENSIONAL ROUGHNESS ON BOUNDARY LAYER TRANSITION AT SUPERSONIC SPEEDS, by E. R. van Driest and W. D. McCauley. Nov. 1958, 50p. incl. illus. diagrs. (Rept. no. MD-59-115) (AFOSR-TN-58-176) (AF 49(638)250) AD 152209

Unclassified

Also published in Jour. Aero/Space Sciences, v. 27: 261-271, Apr. 1960.

Experiments were performed in the 12-inch supersonic wind tunnel of the Jet Propulsion Lab. of Caltech to investigate the effect of three-dimensional roughness elements (spheres) on boundary-layer transition on a 10° (apex angle) cone with zero heat transfer. Data were obtained at local Mach numbers of 1.90, 2.71, and 3.67 by varying trip size, position, spacing, and Reynolds number per inch. The results indicate that (1) transition from laminar to turbulent flow induced by three-dimensional roughness elements begins when the double row of spiral vortices trailing each element contaminates and breaks down the surrounding field of vorticity, (2) transition appears rather sudden, becoming more violent with increasing roughness height relative to the boundary layer thickness, (3) after the breakdown of the vorticity field, the strength of the spiral vortices may still persist in the sub-layer of the ensuing turbulent flow, (4) lateral spacing of roughness elements has little effect upon the initial breakdown (contamination) of the laminar flow, and (5) the trip Reynolds number $(u_k/\nu)_\delta$, where u and ν are the velocity and kinematic viscosity at the outer edge

NAA.04:001; NAA.05:001-005

of the boundary layer and k is roughness height, such that transition occurs at the roughness position, varies as the position Reynolds number to the one-fourth power, viz., $(u_{\infty}/\nu)^{1/4}$, where x_k is trip position.

NAA.04:001

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

SHATTERING OF BURNING AND NON-BURNING PROPELLANT DROPLETS BY SHOCK WAVES, by E. Rabin and F. B. Cramer. Feb. 20, 1958, 12p. incl. diagrs. (Rept. no. R-695) (AFOSR-TN-58-82) (AF 18(603)98) AD 148104 Declassified

Investigations of the effect of shock waves in shattering burning and non-burning droplets of RP-1 have been conducted in a shock tube having a one-inch square cross-section. Test results confirm data of earlier investigators that there are two distinct modes of drop break-up associated with transient and steady-state flow conditions. Much higher "transient" flow velocities (duration of flow less than the natural period of oscillation of the liquid drop) are required to break up a drop than are required for steady flow conditions. The critical velocity for shattering burning droplets appears to be of the order of ten percent lower than for non-burning droplets. There appeared to be little if any difference in drag coefficient between the burning and non-burning droplets; thus, the difference in critical shattering velocity appears to be associated with differences in surface tension of the droplet liquid, not the pressure field around the droplet.

NAA.05:001

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

THE ION ROCKET ENGINE, by R. H. Boden. Rept. for Mar.-June 1957. Aug. 28, 1957, 40p. incl. illus. refs. (Rept. no. R-645) (AFOSR-TN-57-573) (AF 49(838)16) AD 136558 Unclassified

Presented at Soc. Automotive Engineers, National Aeronautic meeting, New York, Apr. 10, 1958.

The significant design parameters of an ion propellant rocket engine are developed in terms of three independent parameters. These are the ratio of the acceleration voltage to atomic or molecular weight of the propellant, gross weight of the vehicle, and thrust-to-weight ratio. Recommendations are presented leading toward advanced study of ion thrust chambers, power generation systems, and propellants. (Contractor's abstract)

NAA.05:002

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

THE ION ROCKET ENGINE, by R. H. Boden. Rept. for Mar.-June 1957. Aug. 28, 1957 (Rev.), 55p. incl. diagrs. tables, refs. (Rept. no. R-658P) (AFOSR-TN-58-44) (AF 49(838)18) AD 211487L Unclassified

Available to U. S. Military Organizations. Others submit requests via Air Force Office of Scientific Research, Wash. 25, D. C. For non-proprietary version see item no. NAA.05:001.

NAA.05:003

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

FLIGHT MECHANICS OF LOW THRUST HIGH ENERGY SPACE VEHICLES, by F. M. Ferebee. Mar. 3, 1958 [37]p. incl. diagrs. (AFOSR-TN-58-254) (AF 49(838)-18) Unclassified

Presented at meeting of the Amer. Rocket Soc., Space Flight Session, Dallas, Tex., Mar. 19, 1958.

Factors affecting space navigation by continuously powered low-thrust vehicles are discussed. Earth-Mars and Earth-Moon trajectories, calculated on the Rocketdyne IBM-704 digital computer installation are employed in discussion of these factors. (Contractor's abstract, modified)

NAA.05:004

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

ION ROCKET STUDY PROGRAM (Unclassified title), by G. P. Sutton. Final rept. Feb. 28, 1958, 327p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-81) (AF 49(638)16) Secret

NAA.05:005

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

ION ROCKET STUDIES (Abstract), by R. H. Boden. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274) (AF 49(638)16; continued by AF 49(638)344) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

NAA.06:001; NOA.01:001, 002

The main objectives of the analytical study were to carry out the general analysis of the ion rocket engine, to establish the significant component and overall design parameters, to define an approach toward an experimental ion thrust chamber, and to determine the engine system thrust level for interplanetary missions. The scope of the study included the complete engine system and its components from the heat source to the exhaust jet. A major conclusion of this study was that three parameters, the ratio of the accelerating voltage to the effective atomic or molecular weight of the propellant per unit charge (V/A), the gross weight of the vehicle M_g , and the thrust-to-weight ratio G , determine the design characteristics of the ion rocket engine.

NAA.06:001

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

CRITICAL POWER SUPPLY PROBLEMS IN ION PROPULSION, by A. L. Huebner and R. H. Boden. [1958] 18p. incl. diagrs. (AFOSR-TN-58-691) (AF 49-(638)244; continuation of AF 49(638)16) Unclassified

Presented at meeting of the Inst. Aeronaut. Sciences and Amer. Rocket Soc., Aug. 5-6, 1958.

A survey is presented of the basic theory and application of ion propulsion. The ion rocket engine system is described and a schematic diagram is included to show its operations and functions. A discussion of power conversion of the ionic propulsion system includes the following: (1) Theoretical considerations; (2) Power source; (3) Thermomechanical power conversion; and (4) Electrical power generation systems. Characteristics required by the Brayton and Rankine cycle working fluids which are to be used as nuclear reactor coolants are given, and assumptions made in analyzing these cycles and calculating the requisite radiator areas are discussed. Important results are also given of the studies of power conversion cycles. Referring to the power plant development program, those areas are delineated which are critical to the power supply system of an ion rocket system.

NOA.01:001

North American Philips Co., Inc. Philips Labs., Irvington-on-Hudson, N. Y.

RESEARCH ON NOISE IN HIGH POWERED KLYSTRONS, by W. R. Atkinson. Mar. 31, 1957, 35p. incl. diagrs. tables. (Technical rept. no. 114) (AFOSR-TN-57-211) (AF 18(603)33) AD 126508 Unclassified

Experimental work was done in an attempt to improve a previously used noise measuring system. The method of attack was to reduce as far as possible extraneous noises that tended to mask the tube noise about which

information was desired. The advantage gained by using several simultaneously excited crystals was demonstrated. A method for resolving the output noise of a crystal into tube noise and crystal noise components was studied. A description is presented of the commercial equipment which was considered as an aid to the study of noise in klystrons. Presentation is made of formulas which have been derived as a result of a theoretical study aimed at understanding the mechanisms which convert beam fluctuations into power and frequency fluctuations of the microwave energy. (Contractor's abstract)

NOA.01:002

North American Philips Co., Inc. Philips Labs., Irvington-on-Hudson, N. Y.

RESEARCH ON NOISE IN HIGH POWERED KLYSTRONS, by W. R. Atkinson. Final rept. May 31, 1958, 44p. incl. illus. diagrs. refs. (Technical rept. no. 129) (AFOSR-TR-58-90) (AF 18(603)33) AD 162122; PB 137551
Unclassified

Several techniques were used to measure the spectral dependence of the mean square frequency deviations of two-cavity klystron oscillators having an integrated rms frequency deviation of a few hundred cycles per second over the entire audio frequency range. Comparison of the measurements with existing theories of electronic noise indicated that mechanisms which were not purely electronic in nature were present in all the klystrons tested. Additional measurements indicated that the rapid rise in the spectral density of frequency fluctuations which occurred in progressing to lower audio frequencies was not the result of microphonic variation of the resonant frequencies of the cavities. Some observations suggested that the noise was connected with temperature fluctuations of critical parts of the klystron. Proposed experiments which would more definitely identify the noise sources were mentioned. (Contractor's abstract)

North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, Paris (France).
See

	<u>item nos.</u>
Columbia U., New York	COU.18:001
Cornell Aeronautical Lab., Inc. Buffalo, N. Y.	COA.01:005
Lovelace Foundation for Medical Education and Research, Albuquerque, N. M.	LOV.01:001
Nelson, W. C., Ann Arbor, Mich.	NEL.02:001
Toronto U. Inst. of Aerophysics (Canada)	TOR.01:009

NCS.01:001, 002; NCU.01:009, 010

NCS.01:001

North Carolina [State Coll.] Inst. of Statistics, Raleigh.

PROCEEDINGS OF SYMPOSIUM ON DESIGN OF INDUSTRIAL EXPERIMENTS, NOV. 5-9, 1956, ed. by V. Chew. Nov. 1956, 374p. incl. diagrs. tables, refs. (AFOSR-TN-57-778) (AF 18(603)55) AD 148008
Unclassified

This symposium (1) provides expository and review papers on the present status of design and statistical techniques available to the research worker, (2) presents newer developments in this field, (3) provides discussions of regression analysis, concepts of randomization, block designs, sequential multiple decisions procedures, and pertinent statistical techniques, and (4) presents examples of actual experiences with various designs in industrial research. The papers by title include: Basic Experimental Designs, by V. Chew; Complete Factorials, Fractional Factorials and Confounding, by R. L. Anderson; Simple and Multiple Regression Analyses, by R. J. Hader and A. H. E. Grandage; Experimental Designs for Exploring Response Surfaces, by G. E. P. Box and J. S. Hunter; Experiences with Incomplete Block Designs, by W. S. Connor; Experiences with Fractional Factorials, by W. H. Horton; Application of Fractional Factorials in a Food Research Laboratory, by M. B. Carroll and O. Dykstra, Jr.; Experiences with Response Surface Designs, by R. M. DeBaun and A. M. Schneider; Experiences and Needs for Design in Ordnance Experimentation, by C. A. Bicking; Analysis of Paired Comparison Designs with Incomplete Repetitions, by J. W. Wilkinson; Examples of Intra-block Analysis for Factorials in Two-associate Class, Group Divisible Designs, by C. Y. Kramer and R. A. Bradley; A Sequential Multiple Decision Procedure for Selecting the Best One of Several Normal Populations with a Common Unknown Variance, and Its Use with Various Experimental Designs, by R. E. Bechhofer; Evolutionary Operation, by G. E. P. Box; and Where Do We Go From Here?, by J. W. Tukey

NCS.01:002

North Carolina [State Coll.] Inst. of Statistics, Raleigh.

EXPERIMENTAL DESIGNS IN INDUSTRY. A SYMPOSIUM HELD NOV. 5-9, 1956, AT NORTH CAROLINA STATE COLLEGE, RALEIGH, ed. by V. Chew. Nov. 1956, 268p. incl. diagrs. tables, refs. [AFOSR-TN-58-572] (AF 18(603)55) AD 158392; LC no. T175.N6 1956
Unclassified

(See item no. NCS.01:001 for the complete coverage of papers presented at the symposium)

NCU.01:009

North Carolina U. Dept. of Chemistry, Chapel Hill.

CONCERNING THE EFFECT OF SURFACE ACTIVE SUBSTANCES ON POLAROGRAPHIC CURRENTS, by R. W. Schmid and C. N. Reilley. Mar. 1957, 25p. diagrs. tables, refs. (Rept. no. UNC-Chem. no. 9-CNR) (AFOSR-TN-57-121) (AF 18(600)1160) AD 120476
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 2087-2094, May 5, 1958.

Surface active materials have a marked effect upon electrode processes and a systematic investigation of various ways by which this action takes place in polarography is reported. Oscillographic current-time curves during the life of single mercury drops furnish considerably more information than usual polarograms and a detailed study of such curves allows an interpretation of the various types of phenomena encountered. The time delay usually observed before the surface active material affects the electrode process is explained from the viewpoint of diffusion-controlled transport of the surface active agent to the electrode and of the rate of its adsorption on the electrode. The inhibition of the electrode process, caused by the adsorption of the surface active material at the electrode, is discussed with chief attention devoted to the mechanism and kinetics of electrode reactions. The ideas presented can readily be extended to explain unusual polarographic waves observed in other cases, such as in electrode processes where insoluble or strongly surface active products of the electrode reaction are formed. (Contractor's abstract)

NCU.01:010

North Carolina U. Dept. of Chemistry, Chapel Hill.

DIRECT TITRATION OF CALCIUM IN BLOOD SERUM, by R. L. Golby, G. P. Hildebrand, and C. N. Reilley. May 1957, 9p. incl. tables. (Rept. no. UNC-Chem. no. 10-CNR) (AFOSR-TN-57-471) (AF 18(600)1160) AD 136463
Unclassified

Also published in Jour. Lab. Clin. Med., v. 50: 498-500, Sept. 1957.

A direct titration for the rapid determination of calcium in serum employing calcon as an indicator is presented. The results obtained by this proposed method indicate a degree of accuracy and reproducibility closely approximating that of the classical permanganate titration of precipitated calcium oxalate. The average time required for duplicate titrations is less than five minutes.

NCU.01:011 - NCU.01:015

NCU.01:011

North Carolina U. Dept. of Chemistry, Chapel Hill.

CHELOMETRIC TITRATIONS WITH POTENTIOMETRIC ENDPOINT DETECTION. MERCURY AS A pM INDICATOR ELECTRODE. PART I. PRINCIPLES, by C. N. Reilley and R. W. Schmid. June 1957 [23]p. incl. diagrs. table. (Rept. no. UNC-Chem. no. 11-CNR) (AFOSR-TN-57-472) (AF 18(600)1160) AD 136464
Unclassified

Also published in Anal. Chem., v. 30: 947-953, May 1958.

Principles concerning the use of mercury as a pM indicator electrode for chelometric titrations are described. The effect of pH, buffer type and concentration, chelon, and metal ion on the potentiometric titration curve may be quantitatively determined in terms of potential-pH diagrams. The interference levels of competitive redox systems - e.g., chloride, iodide, sulfate, and oxygen - are considered similarly. The mercury electrode may also be used to characterize a new chelon in its interaction with various metal ions.

NCU.01:012

North Carolina U. Dept. of Chemistry, Chapel Hill.

CHELOMETRIC TITRATIONS WITH POTENTIOMETRIC ENDPOINT. PART II. TITRATIONS OF METAL IONS WITH EDTA, by C. N. Reilley, R. W. Schmid, and D. W. Lamson. June 1957 [18]p. incl. diagrs. tables. (Rept. no. UNC-Chem. no. 12-CNR) (AFOSR-TN-57-473) (AF 18(600)1160) AD 136465
Unclassified

Also published in Anal. Chem., v. 30: 953-957, May 1958. (Title varies)

The alkaline earth, rare earth, a large number of transition and heavy metals may be titrated with EDTA potentiometrically using a mercury electrode. Both direct and back titration procedures are employed and the results for 29 metal ions indicate an average titration accuracy of 0.1 - 0.4%. The conditions of titration of individual metal ions are described. Through judicious application of the pH effect, many multicomponent mixtures can be analyzed. The titration of a mixture containing bismuth, cadmium, and calcium is given as an example. (Contractor's abstract)

NCU.01:013

North Carolina U. Dept. of Chemistry, Chapel Hill.

SELECTIVE TITRATIONS OF METAL IONS WITH TRIETHYLENETETRAMINE, by C. N. Reilley and M. V. Sheldon. July 1957 [8]p. incl. table, refs. (Rept. no. UNC-Chem. no. 13-CNR) (AFOSR-TN-57-474) (AF 18(600)1160) AD 136466
Unclassified

Presented at meeting of the Analyt. Chem. Div. of the Amer. Chem. Soc., New York, Sept. 8-13, 1957.

Abstract published in 132nd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 30-B.

Also published in Chemist. Analyst, v. 46: 59-60, 1957.

Triethylenetetramine, a typical polyamine with the structure, $H_2N-CH_2-CH_2-NH-CH_2-CH_2-NH-CH_2-CH_2-NH_2$, forms very stable, soluble, 1:1 complexes with cobalt, nickel, copper, zinc, cadmium, and mercury. Consequently, this chelon is useful for the titration of these metal ions. In addition, it appeared to offer special advantages since the alkaline earths and rare earths, as expected, do not react with triethylenetetramine and consequently would not interfere in the titration. (Contractor's abstract)

NCU.01:014

North Carolina U. Dept. of Chemistry, Chapel Hill.

STABILITY OF METAL-TRIETHYLENETETRAMINE COMPLEXES, by C. N. Reilley and R. W. Schmid. July 1957 [10]p. incl. diagr. table. (Rept. no. UNC-Chem. no. 14-CNR) (AFOSR-TN-57-475) (AF 18(600)1160) AD 136467
Unclassified

Also published in Jour. Elisha Mitchell Scientific Soc., v. 73: 279-284, Nov. 1957.

Polyamines such as triethylenetetramine are expected to complex selectively certain transition metals (cobalt, nickel, copper, zinc, cadmium, and mercury) which are known to form stable amines. The mercury electrode was employed for measuring potentiometrically the stability constants of these metal-triethylenetetramine complexes and log k values of 25.0 (Hg), 20.1 (Cu), 14.1 (Ni), 11.9 (Zn), 10.8 (Cd), and 10.4 (Pb) were obtained at 25.0°C, $\mu = 0.1$. Magnesium, calcium, strontium, barium, aluminum, lanthanum, and bismuth gave only negligible values. (Contractor's abstract)

NCU.01:015

North Carolina U. [Dept. of Chemistry] Chapel Hill.

THE INFLUENCE OF INERT CATIONS ON THE REDUCTION OF COMPLEX ANIONS. POLAROGRAPHY OF THE CADMIUM EDTA COMPLEX, by R. W. Schmid and C. N. Reilley. Aug. 1957 [21]p. incl. diagrs. table, refs. (Rept. no. UNC-Chem. no. 15-CNR) (AFOSR-TN-57-522) (AF 18(600)1160) AD 136506
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 2101-2105, May 5, 1958.

The polarographic behavior of the cadmium ethylene

NCU.01:016 - NCU.01:019

diamine tetraacetate complex (CdY^{4-}) has been studied. Kinetic waves of three different types were found. Between pH 1 and 4 a kinetic wave attributed to free cadmium ions, dissociated from the complex, occurs. In the pH region from 2 to 5 a second wave occurs which results from the reduction of the species CdYH^- . Above pH 3.5 this wave is controlled by the rate of recombination of CdY^{4-} with hydrogen ions to form CdYH^- . In the pH region above 4 the wave height is independent of pH and yet is strongly dependent on kind, charge and concentration of "inert" cations present in solution. The cation effect is attributed to the formation of an ion pair between CdY^{4-} and the cation or to the formation of an activated bridge complex involving the surface of the mercury electrode, the cation and the CdY^{4-} . The ion pair or activated bridge complex is then reducible, in contrast to the species CdY^{4-} . The kinetics of the formation of such ion associates or complexes are discussed. (Contractor's abstract)

NCU.01:016

North Carolina U. Dept. of Chemistry, Chapel Hill.

METHODS OF INDIRECT SPECTROPHOTOMETRY. DETERMINATION OF CALCIUM OR MAGNESIUM, by C. N. Reilley and G. P. Hildebrand. Aug. 1957 [17]p. incl. diagrs. tables, refs. (Rept. no. UNC-Chem. no. 16-CNR) (AFOSR-TN-57-523) (AF 18(600)1160) AD 234956 Unclassified

Also published in Anal. Chem., v. 31: 1763-1766, Nov. 1959.

Inquiry is made into the modes of photometric measurement in cases where the introduction of sample causes a decrease in absorbance of the chromogenic reagent solution. Four methods are distinguished, of which two are new. These new methods yield a linear absorption scale versus concentration plot analogous to the usual "Beer's Law" and "Transmittance-Ratio" relationships. Magnesium is determined using calcon as the chromogenic reagent and calcium in a similar way by introduction of magnesium-EDTA to the calcium solution. The sensitivity of the method is 0.003 (Mg) and 0.005 (Ca)

micrograms per cm^2 per 0.001 absorption units. (Contractor's abstract)

NCU.01:017

North Carolina U. Dept. of Chemistry, Chapel Hill.

ULTRAMICRO CHELOMETRIC TITRATIONS WITH POTENTIOMETRIC END POINT DETECTION, by F. S. Sadek and C. N. Reilley. Dec. 1957 [23]p. incl. diagrs. tables. (Rept. no. UNC-Chem. no. 17-CNR) (AFOSR-TN-57-788) (AF 18(600)1160) AD 148019 Unclassified

Also published in Microchem. Jour., v. 1: 183-201, 1957.

Chelometric titrations with EDTA have been successfully applied to the ultramicro determination of certain metal ions using various metallochromic indicators for end point detection. These indicator methods, in addition to being tedious and often disturbed by the presence of certain other trace metal ions, failed for the analysis of certain metal ions such as barium or strontium. Furthermore a given metallochromic indicator is applicable on a macro scale only to a restricted set of metal ions and conditions of pH and buffer type. In contrast the mercury electrode has been employed for potentiometric end point detection for the analysis of whole and fractional microgram amounts of metal ions. The results indicate that this procedure is a general one, applicable for most metal ions over a wide range of pH using different buffer solutions and several types of chelons. (Contractor's abstract)

NCU.01:018

North Carolina U. Dept. of Chemistry, Chapel Hill.

THE STABILITY OF METAL-TETRAETHYLENE-PENTAMINE COMPLEXES, by C. N. Reilley and J. H. Holloway. Dec. 1957, 10p. incl. diagr. tables, refs. (Rept. no. UNC-Chem. no. 18-CNR) (AFOSR-TN-57-789) (AF 18(600)1160) AD 148020 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 2917-2919, June 20, 1958.

The stability constants for the reaction between a series of divalent and trivalent metal ions with tetraethylene-pentamine have been determined by potentiometric measurements. The complexes studied were those of Hg^{2+} (27.7), Cu^{2+} (22.9), Ni^{2+} (17.8), Zn^{2+} (15.4), Cd^{2+} (14.0), Pb^{2+} (10-11), Mn^{2+} (7.0), Bi^{3+} (> 0), Ca^{++} (—), Mg^{++} (—), Sr^{++} (—), Ba^{++} (—), Al^{3+} (—), and La^{3+} (—). The reported log K values were obtained at $25.00 \pm 0.01^\circ$ and at an ionic strength of 0.10. A new method for determining the acidity constants of tetraethylene-pentamine is described. (Contractor's abstract)

NCU.01:019

North Carolina U. Dept. of Chemistry, Chapel Hill.

INDIRECT CHELOMETRIC ANALYSIS WITH THE AID OF LIQUID AMALGAMS, by W. G. Scribner and C. N. Reilley. Jan. 1958 [41]p. incl. diagrs. tables, refs. (Rept. no. UNC-Chem. no. 19-CNR) (AFOSR-TN-58-60) (AF 18(600)1160) AD 148102 Unclassified

Also published in Anal. Chem., v. 30: 1452-1462, Sept. 1958.

The application of liquid amalgams lends a new perspective to the field of chelometric titrations. The principle

NCU.01:020; NCU.02:005-007

involves reduction of one or more components of the sample by a metal amalgam with liberation of an equivalent quantity of metal ion from the amalgam. Thus species (e.g. Ag(I) or Tl(I)) which are not readily amenable to direct EDTA titration can be reduced with zinc amalgam, the zinc ions liberated being easily titrated. Another application is to swap an easily masked metal (Cu(II)) for one that is not masked (Pb(II)) or vice versa (e.g. Zn(II) for Pb(II)). In addition, advantage can be taken of the difference between equivalent weights for reduction and for chelometric titration, e.g. analysis of a Bi(III), Pb(II) mixture by titration of aliquots before and after reduction with zinc amalgam. Certain multi-component mixtures as well as reducible organic compounds can be analyzed by these techniques. The method is related to controlled-potential coulometry and similar equations apply, the titration yielding a rapid convenient integration of the current-time curve. An important advantage of the amalgam method is the greatly decreased time required for quantitative reduction (half-reduction in 15-20 sec). A complete operation from introduction of sample through final titration requires only 15-20 min. (Contractor's abstract)

NCU.01:020

North Carolina U. [Dept. of Chemistry] Chapel Hill.

SELECTIVE POTENTIOMETRIC TITRATION OF METAL IONS WITH TRIETHYLENETETRAMINE, by C. N. Reilly and M. V. Sheldon. [1958] [11]p. incl. diagrs. tables, refs. [AF 18(600)1160] Unclassified

Presented at Fifteenth Congress of the Internat'l. Union of Pure and Appl. Chem., Lisbon (Portugal), 1956.

Published in *Talanta*, v. 1: 127-137, July 1958.

The theoretical conditions necessary for the potentiometric titration of metal ions with triethylenetetramine ("trien") and for the selective titration of mixtures of ions with this reagent, alone or in conjunction with EDTA, are discussed. It is shown that it is possible to choose conditions suitable for selective titrations, and this is illustrated by titrations of Cu, Zn, Ni, Cd and Hg, singly and in two-component mixtures. Alkaline earths do not interfere in the titrations. (Contractor's abstract)

NCU.02:005

North Carolina U. Dept. of Mathematics, Chapel Hill.

DIFFERENTIAL SYSTEMS WITH INTERFACE AND GENERAL BOUNDARY CONDITIONS, by T. J. Pignani and W. M. Whyburn. [1956] [15]p. (AFOSR-TN-57-242) (AF 18(600)1139) AD 102008 Unclassified

Also published in *Jour. Elisha Mitchell Scientific Soc.*, v. 72: 1-14, May 1956.

In the first part the authors study the system (1) $Y' + P(x)Y = Q(x)$, (2) $A_r Y(t_r^+) + B_r Y(t_r^-) = C_r$ ($r = 1, 2, \dots, m-1$), (3) $AY(a) + BY(b) + \int_a^b F(s)Y(s)ds = D$.

Capital letters in (1), (2), (3) denote $(n \times n)$ matrices; A_r, B_r, C_r, A, B and D are matrices of constants, while $P(x), Q(x)$ and $F(x)$ are Lebesgue summable matrix functions of the real variable x on the interval (a, b) . (2) are interface conditions. The interface points t_1, t_2, \dots, t_{m-1} are $Y(t_r^\pm)$ designate the limits of $Y(t)$ as t approaches the point t_r from the left and right, respectively.

A d -solution of (1) and (2) on (a, b) is a matrix, $Y(x)$, which is absolutely almost everywhere continuous on (t_{i-1}, t_i) ($i = 1, 2, \dots, m$) satisfies (1) almost everywhere on (a, b) and satisfies (2). (3) are general boundary conditions. The results of the authors are extensions of those of Stallard (Oak Ridge Nat'l. Lab. Rep. ORNL 1876 (1955)). The second part is concerned with the same system with the exception that the number of interface points may be countably infinite. (Math. Rev. abstract)

NCU.02:006

North Carolina U. Dept. of Mathematics, Chapel Hill.

AN OPTIMUM EXPLICIT RECURRENCE FORMULA FOR THE DIFFUSION EQUATION, by W. R. Mann and W. P. Timlake. [1958] [4]p. (Rept no. 7) (AFOSR-TN-58-249) (AF 18(600)1139) AD 154152 Unclassified

Also published in *Jour. Elisha Mitchell Scientific Soc.*, v. 73: 254-257, Nov. 1957.

The purpose of this paper is to show how the method for reducing truncation error illustrated in AFOSR-TN-56-57 (item no. NCU.02:004) leads quite naturally to the results of S. H. Crandall ("An optimum implicit recurrence formula for the heat equation," *Quart. Appl. Math.*, v. 13: 318-320, 1955) and also to an optimum explicit formula which is shown to be stable for

$$\frac{\Delta t}{(\Delta x)^2} \leq 1/3.$$

NCU.02:007

North Carolina U. [Dept. of Mathematics] Chapel Hill.

ON A NONLINEAR INTEGRAL EQUATION, by K. Padmavally. Jan. 1958, 32p. (Rept. no. 8) (AFOSR-TN-58-598) (AF 18(600)1139) AD 162123

Unclassified

NCU.02:008-010; NCU.03:003, 004

Also published in Jour. Math. and Mech., v. 7: 533-555, July 1958.

This report is a study of the problem $U_{xx}(x,t) = U_t(x,t)$ $x > 0$, $t > 0$ with the boundary conditions $U(x,0) = 0$ and $U_x(0,t) = g[U(0,t), \phi(t)]$ which corresponds to nonlinear diffusion from a variable heat source to a semi-infinite rod initially at zero temperature throughout. The problem is reduced to a nonlinear integral equation of the form

$$y(t) = \int_0^t \frac{G[y(\tau), \tau]}{\sqrt{\pi(t-\tau)}} d\tau.$$

Existence and uniqueness theorems are established under the most general, physically reasonable hypotheses on g , and ϕ . It is shown that if the variable source temperature $\phi(t)$ is non-negative and non-decreasing, then the surface temperature $U(0,t)$ is non-decreasing and lies between 0 and $\phi(t)$ for all $t \geq 0$. If $\lim_{t \rightarrow \infty} \phi(t) = 1$,

then $\lim_{t \rightarrow \infty} U(0,t)$ also exists, and is also equal to 1.

Furthermore, $U(x,t)$ is found to be a non-decreasing functional of $\phi(t)$. (Contractor's abstract)

NCU.02:008

North Carolina U. [Dept. of Mathematics] Chapel Hill.

A POINCARÉ PROBLEM, by K. Padmavally. July 1958, 30p. (Rept. no. 9) (AFOSR-TN-58-599) (AF 18(600)-1139) AD 162124 Unclassified

Also published in Jour. Indian Math. Soc., v. 22: 181-205, 1959.

A solution of the partial differential equation $\phi_{xx} + \phi_{yy} = \phi - 1$ is sought, which approaches 1 at infinity, and vanishes on the closed segment $[0, 1]$ of the x axis. These conditions are satisfied by the density ϕ of neutrons in a reactor (assumed to be infinite) in which the portion $0 < x < 1$ of the y -plane is occupied by a control rod. The symmetry of the problem about the x -axis reduces the problem to determining a solution ϕ of the differential equation in the upper half-plane, which vanishes on the closed segment $[0, 1]$ of the x axis, approaches 1 at infinity, and has zero normal derivative on the rest of the boundary. Using a suitable Neumann function this problem is reduced to the solution of a Fredholm equation of the first kind. Then using a formula due to W. Schneidler it is further reduced to the solution of a Fredholm equation of the second kind. (Contractor's abstract)

NCU.02:009

North Carolina U. Dept. of Mathematics, Chapel Hill.

[SOLUTIONS OF NON-LINEAR DIFFERENTIAL EQUATIONS] by W. M. Whyburn and W. R. Mann. [Final] technical rept. Nov. 1958, 2p. (Rept. no. 10) (AFOSR-TR-58-152) (AF 18(600)1139) AD 206157

Unclassified

The principal results of the research performed under this contract have been reported in professional journal articles or in technical notes. The present report contains a list of the 8 publications resulting from this work.

NCU.02:010

North Carolina U. Dept. of Mathematics, Chapel Hill.

EQUIVALENT NONLINEAR PROBLEMS, by W. R. Mann. [1958] [3]p. (AF 18(600)1139) Unclassified

Published in Jour. Elisha Mitchell Scientific Soc., v. 74: 114-116, Nov. 1958.

In earlier papers (Quart. Appl. Math., v. 9: 163-184, 1951 and Proc. Amer. Math. Soc., v. 5: 979-987, 1954) certain nonlinear diffusion problems in which the non-linearity occurs in a boundary condition have been treated rather completely. In this paper it is shown that these problems are equivalent to, i.e. have the same solutions as, certain boundary value problems in which all boundary conditions are linear but the differential equation is quasi-linear.

NCU.03:003

North Carolina U. Dept. of Mathematics, Chapel Hill.

INTERVALS FOR THE CHARACTERISTIC ROOTS OF AN HERMITIAN MATRIX, by A. T. Brauer and A. C. Mewborn. Oct. 1957, 13p. incl. refs. (Technical rept. no. 5) (AFOSR-TN-57-343) (AF 18(603)38) AD 132416 Unclassified

Also published in Jour. Elisha Mitchell Scientific Soc., v. 73: 247-254, Nov. 1957.

Using the Separation Theorem for Hermitian matrices, intervals for each of the n characteristic roots are obtained. The method used is often simpler and gives better bounds than that of Ky Fan. (Contractor's abstract)

NCU.03:004

North Carolina U. [Dept. of Mathematics] Chapel Hill.

A METHOD FOR THE COMPUTATION OF THE

NCU.03:005; NCU.04:033, 034

GREATEST ROOT OF A POSITIVE MATRIX, by A. [T.] Brauer. Dec. 1957, 6p. (Technical rept. no. 6) (AFOSR-TN-57-751) (AF 18(603)38) AD 136739
Unclassified

Presented at Conf. on Matrix Computations, Wayne State U., Detroit, Mich., Sept. 3-6, 1957.

Also published in Jour. Soc. Indust. Appl. Math., v. 5: 250-253, Dec. 1957.

A theorem of Perron (Math. Ann., v. 64: 248-263, 1907) and Frobenius (Sitzungsberichte Preussischen Akad. Wissensch. Berlin, 1908: 471-478 and 1909: 514-518) states that a positive matrix A of order n has a positive characteristic root ω^* which is simple and greater than the absolute value of the other roots. This root lies between the greatest and smallest row-sum, and it is greater than the maximum of the main diagonal elements. The coordinates of a characteristic vector belonging to ω^* can be chosen as positive numbers. For all these results, a new simple proof has been published (Duke Math. Jour., v. 24: 367-378, 1957). Not only the existence of ω^* is proved, but also a convergent method is obtained for the computation of ω^* . This mathematical study is concerned with improving the original method in order to obtain a quicker convergence and to simplify the computation by replacing square roots of row-sums by rational functions of them. It is now shown that the greatest positive root of a positive matrix can be found as exactly as needed by multiplying certain rows successively by given constants and dividing the corresponding columns by these constants.

NCU.03:005

North Carolina U. Dept. of Mathematics, Chapel Hill.

LIMITS FOR THE CHARACTERISTIC ROOTS OF A MATRIX. VII, by A. T. Brauer. July 1958, 14p. incl. diagr. (AFOSR-TN-58-659) (AF 18(603)38) AD 162190
Unclassified

Also published in Duke Math. Jour., v. 25: 583-590, Dec. 1958.

In the recently published book of E. Bodewig, *Matrix Calculus*, some results of an earlier paper of this author are mentioned. Bodewig states that this author obtained $n(n-1)/2$ ovals of Cassini which contain the characteristic roots of a given square matrix of order n instead of the well-known n circles for these roots. Bodewig also states that these results are of theoretical interest, but have no practical value. In this paper it is shown that they can easily be used for practical computations.

NCU.04:033

North Carolina U. Inst. of Statistics, Chapel Hill.

CONFIDENCE BOUNDS ON THE "RATIO OF MEANS" AND THE "RATIO OF VARIANCE" FOR CORRELATED VARIATES, by S. N. Roy and R. F. Potthoff. May 1957, 16p. (Mimeograph series no. 170) (AFOSR-TN-57-210) (AF 18(600)83; continued by AF 49(638)213) AD 126507
Unclassified

Presented at meeting of the Inst. of Math. Stat., Atlantic City, N. J., Sept. 10-13, 1957.

Abstract published in Ann. Math. Stat., v. 28: 1059, Dec. 1957.

Also published in Ann. Math. Stat., v. 29: 829-841, Sept. 1958. (Title varies)

In this paper confidence bounds are obtained (1) on the ratio of variances of a (possibly) correlated bivariate normal population, and then by generalization; (2) on a set of parametric functions of a (possibly) correlated $p + p$ variate normal population, which plays the same role for a $2p$ -variate population as the ratio of variances does for the bivariate case; (3) on the ratio of means of the population indicated in (1) and, by generalization; and (4) on a set of parametric functions of the population indicated in (2), which plays the same role for this problem as the ratio of means does for the bivariate case.

NCU.04:034

North Carolina U. Inst. of Statistics, Chapel Hill.

TESTS OF MULTIPLE INDEPENDENCE AND THE ASSOCIATED CONFIDENCE BOUNDS, by S. N. Roy and R. Bargmann. June 1957, 23p. (Mimeograph series no. 175) (AFOSR-TN-57-380) (AF 18(600)83) AD 132455
Unclassified

Presented at meeting of the Inst. of Math. Stat., Atlantic City, N. J., Sept. 10-13, 1957.

Abstract published in Ann. Math. Stat., v. 28: 1059, Dec. 1957.

Also published in Ann. Math. Stat., v. 29: 491-503, June 1958.

A test based on the union-intersection principle is proposed for over-all independence between p variates distributed according to the multivariate normal law, and this is extended to the hypothesis of independence between several groups of variates which have a joint multivariate normal distribution. Methods used previously (NCU.04:029) are applied in order to invert these tests for each situation and to obtain simultaneous confidence bounds on certain parametric functions, with a joint

NCU.04:035 - NCU.04:037

confidence coefficient greater than or equal to a preassigned level. In case I, these parametric functions are the moduli of the regression vectors of the variate p on the variates $(p-1)$, $(p-2)$, ... 2, 1, or on any subset of the latter; of the variate $(p-1)$ on the variates $(p-2)$, $(p-3)$... 2, 1, or any subset of the latter, etc.; and finally of the variate 2 on the variate 1. In case II, parallel to each case above, there is an analogous statement in which the regression vector is replaced by a regression matrix β , and the modulus of the regression vector is replaced by the positive square root of the largest characteristic root of (β, β') . Simultaneous confidence bounds on these sets of parameters are given. The proposed tests of hypotheses of multiple independence are an alternative to another class of tests on the likelihood-ratio criterion (S. S. Wilks, *Biometrika*, v. 24, 1932; and *Econometrica*, v. 3, 1935).

NCU.04:035

North Carolina U. Inst. of Statistics, Chapel Hill.

NEW DESIGNS FOR THE EXPLORATION OF RESPONSE SURFACES, by R. L. Carter. May 1957, 134p. incl. diagr. tables, refs. (Mimeograph series no. 172) (AFOSR-TN-57-381) (AF 18(600)83) AD 132456

Unclassified

An investigation is made of the theory of experimental designs for the exploration of response surfaces. A historical background is given for the concept of response surfaces, which points out the necessarily sequential nature of the exploration and the importance of the concept of rotatability. The relationship is discussed between the conventional factorial design and the designs employed in the exploration of response surfaces. A model is presented which gives the response corresponding to any point in the factor space in terms of the component-functions which depend only on the experimental levels employed. Examples are included which show the response expressed as a linear combination of the conventional effect and interactions. In the general multifactor case, the transformation between the conventional effects and the responses at the sample point is shown to be the Kronecker product of matrices whose elements are component-functions for the individual factors. Configurations of points which are unequally spaced are considered; circular designs are obtained when 2 factors are employed. A procedure is given for computing the general nonsymmetric design. Proof is given for a theorem which states the necessary and sufficient conditions for a configuration of sample points to be a rotatable arrangement of specified order. The theorem is applied to cases of configurations possessing a higher order of rotatability.

NCU.04:036

North Carolina U. Inst. of Statistics, Chapel Hill.

TESTING OF HYPOTHESES ON A MULTIVARIATE POPULATION, SOME OF THE VARIATES BEING CONTINUOUS AND THE REST CATEGORICAL, by M. D. Moustafa. July 1957, 26p. refs. (Mimeograph series no. 179) (AFOSR-TN-57-440) (AF 18(600)83) AD 136430

Unclassified

Presented at meeting of the Inst. of Math. Stat., Washington, D. C., Mar. 7-9, 1957.

Abstract published in *Ann. Math. Stat.*, v. 28: 528, June 1957.

A $(k+1)$ -variate distribution is considered in which k variates are continuous and 1 variate is categorical. The k variates are assumed to have a conditional multivariate normal distribution with respect to the 1 categorical variates which are assumed to have a multinomial distribution. Appropriate hypotheses are framed in this situation, analogous to the customary hypotheses on a single multivariate normal distribution, large sample tests of such hypotheses are developed and some of their properties studied. Instead of assuming a single multinomial distribution on the 1 categorical variates, a product of multinomial distributions is assumed (in case some of the 1-categorical are ways of classification) and hypotheses are framed in this situation analogous to the customary ones for several multivariate normal distributions, and large sample tests of such hypotheses and some of their properties are studied. (Contractor's abstract)

NCU.04:037

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE ASYMPTOTIC DISTRIBUTION OF THE LIKELIHOOD RATIO IN SOME PROBLEMS ON MIXED VARIATE POPULATIONS, by J. Ogawa, M. D. Moustafa, and S. N. Roy. Aug. 1957, 36p. (Mimeograph series no. 180) (AFOSR-TN-57-498) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)83 and Office of Naval Research under Nonr-85506) AD 136488

Unclassified

The asymptotic distribution is studied of the statistic $-2 \log \lambda$ defined for testing with hypotheses of certain types on a mixed variates population. A rigorous proof is presented of the fact that $-2 \log \lambda$, on Doob's (*Trans. Amer. Math. Soc.*, v. 36: 759-775, 1934) assumptions, has an asymptotic χ^2 -distribution. The problem of testing hypotheses in the 3-variates (X, Y, Z) population, where X, Y , are continuous and Z is categorical is explained. A theorem is established which guarantees the consistency and the uniqueness of the solution of the

NCU.04:038 - NCU.04:041

maximum likelihood equation. The validity of Doob's conditions and the assumption of the theorem are verified for the case of 3-variate population. (Contractor's abstract)

NCU.04:038

North Carolina U. [Inst. of Statistics] Chapel Hill.

A NOTE ON A CLASS OF PROBLEMS IN "NORMAL" MULTIVARIATE ANALYSIS OF VARIANCE, by S. N. Roy and J. Roy. Nov. 1957, 7p. (Mimeograph series no. 184) (AFOSR-TN-57-749) (AF 18(600)83) AD 136737; PB 132980 Unclassified

Also published in Ann. Math. Stat., v. 30: 577-581, June 1959.

Let the columns of X ($p \times n$) be independent non-singular p -dimensional normal variates with a common variance-covariance matrix and expectations given by

$$EX' = A\xi,$$

where A ($n \times m$) is a matrix of known constants and ξ ($m \times 1$) is a matrix of unknown parameters. This will be called the model. Under this model consider the hypothesis

$$H: \xi = B\eta,$$

where B ($m \times k$) is a given matrix of constants and η ($k \times 1$) is a matrix of unknown parameters. It is shown that the hypothesis H is "completely testable" if and only if

$$\text{rank } A + \text{rank } B - \text{rank } AB = m.$$

Further, if $\text{rank } A \leq n-p$, it is always possible to construct a testable hypothesis H^* which is implied by H ; the test-criterion proposed for H^* is based on the latent roots of the matrix $S_2 S_1^{-1}$ where S_1 and $(S_1 + S_2)$ are the "error-matrices of sums of squares and products" under the model and under H^* respectively. It is further shown that the rank of the matrix S_2 is $\min[p, \text{rank } A - \text{rank } (AB)]$. (Contractor's abstract)

NCU.04:039

North Carolina U. [Inst. of Statistics] Chapel Hill.

SOME ASPECTS OF MULTIVARIATE ANALYSIS, by S. N. Roy. N. Y., John Wiley and Sons, Inc., 1957, 214p. Incl. refs. [AF 18(600)83] Unclassified

Samples of a fixed size are treated with the chief emphasis on obtaining confidence bounds on certain parametric functions that are a set of natural measures of deviation from a null hypothesis. The first twelve chapters lead up to the confidence bounds which are discussed in detail in chapters 13 and 14. In chapter 15,

some nonparametric generalizations of analysis of variance and multivariate analysis applied to categorized data in contingency tables are considered. The underlying basis is a heuristic class of tests and a union-intersection principle. Included in the first twelve chapters are discussions of the multivariate normal population and the properties of samples therefrom, distribution problems, least squares, analysis of variance and generalizations, and bounds on the power functions. There are nine appendices included, covering results in matrix theory, quadratic forms, transformations, roots of determinantal equations, Jacobians, canonical reduction of certain distribution problems and integration, in particular, that connected with the distributions of the smallest and largest roots of a determinantal equation. The multivariate confidence bounds discussed are those for multivariate normal populations relating to (a) the mean vector; (b) mean differences in k populations; (c) the general linear hypothesis; (d) multicollinearity of means; (e) the covariance matrix; (f) characteristic roots related to a pair of covariance matrices; (g) regression-like parameters. Chi-square test criteria and results on large-sample distributions are given in relation to the contingency table hypotheses in chapter 15.

NCU.04:040

North Carolina U. Inst. of Statistics, Chapel Hill.

STEP-DOWN PROCEDURE IN MULTIVARIATE ANALYSIS, by J. Roy. Dec. 1957, 18p. (Mimeograph series no. 187) (AFOSR-TN-58-33) (AF 18(600)83) AD 148072 Unclassified

Also published in Ann. Math. Stat., v. 29: 1177-1187, Dec. 1958.

The step-down procedure is applied to the multivariate analysis of variance and the comparison of variance-covariance matrices in order to derive new tests of significance and simultaneous confidence-bounds on a number of deviation-parameters. The step-down procedure is not invariant under a permutation of the variates and should be used only when the variates can be arranged on a priori grounds. Some advantages of the step-down procedure are that (1) the procedure uses widely known statistics like the variance-ratio; (2) the test is carried out in successive stages and if significance is established at a certain stage, one can stop at that stage; and (3) it leads to simultaneous confidence-bounds on certain meaningful parametric functions.

NCU.04:041

North Carolina U. Inst. of Statistics, Chapel Hill.

ON LINEAR ASSOCIATIVE ALGEBRAS CORRESPONDING TO ASSOCIATION SCHEMES OF PARTIALLY BALANCED DESIGNS, by R. C. Bose and D. M. Meeker.

NCU.04:042 - NCU.04:046

Jan. 1958, 28p. incl. refs. (Mimeograph series no. 188) (AFOSR-TN-58-78) (In cooperation with Michigan State U.) (AF 18(600)83) AD 148126 Unclassified

Also published in Ann. Math. Stat., v. 30: 21-38, Mar. 1959.

A basic lemma is presented which relates a set of incidence matrices B_1 of order v as the associated

matrices of a partially balanced incomplete block design with m associated classes. Applications of this lemma are given in verifying the existence of a design with a given association scheme. Results are given concerning the characteristic roots and multiplicities of the roots of matrices formed from the B_1 .

NCU.04:042

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON CONFIDENCE BOUNDS CONNECTED WITH THE HYPOTHESIS OF EQUALITY OF TWO DISPERSION MATRICES, by S. N. Roy. Feb. 1958, 6p. (Mimeograph series no. 190) (AFOSR-TN-58-141) (AF 18(600)83) AD 152168; PB 134650 Unclassified

The derivation is given of results previously presented (see item no. NCU.04:029).

NCU.04:043

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON INVERTING A CERTAIN TYPE OF PATTERNED MATRIX, by S. N. Roy. Feb. 1958, 3p. (Mimeograph series no. 191) (AFOSR-TN-58-143) (AF 18(600)83) AD 152170 Unclassified

The inverse is obtained for matrices of the type $D_{a_1}(n \times n) + B(n \times m)C(m \times n)$ where $D_{a_1}(n \times n)$ is an $n \times n$ diagonal matrix whose diagonal elements are a_1, a_2, \dots, a_n are all positive. The inversion is to be obtained subject to the following conditions: (1) $m < n$, (2) both D_{a_1} and $D_{a_1} + BC$ are nonsingular, (3) both

B and C are of rank m , and (4) $l(m \times m)C(m \times n)D_{1/a_1}$

$(n \times n)B(n \times m)$ are nonsingular. The inverse of this type of matrix, with $C = B'$, $m < n$ and l a D_{a_1} which

has all the diagonal elements positive is needed in factor analysis and certain other areas of statistics.

NCU.04:044

North Carolina U. Inst. of Statistics [Chapel Hill].

A STUDY OF INDEPENDENCE AND DEPENDENCE IN MULTIVARIATE NORMAL ANALYSIS, by R. Bargmann. Dec. 1957, 95p. incl. tables, refs. (Mimeograph series no. 186) (AFOSR-TN-58-242) (AF 18(600)83) AD 154144; PB 135374 Unclassified

This report deals with the following aspects of multivariate analysis: (1) tests of independence and associated confidence bounds; (2) tests of quasi-independence and associated confidence bounds; (3) generalized distributions and the problem of confidence statements; (4) reducible patterns of dependence; (5) degrees of dependence; and (6) numerical illustrations.

NCU.04:045

North Carolina U. Inst. of Statistics, Chapel Hill.

SOME USES OF THE DISTRIBUTION OF THE LARGEST ROOT IN MULTIVARIATE ANALYSIS, by D. L. Heck. Mar. 1958, 46p. incl. diagrs. tables, refs. (Mimeograph series no. 194) (AFOSR-TN-58-290) (AF 18(600)83) AD 154195 Unclassified

There has been only limited application of the distribution of characteristic roots for testing purposes and construction of confidence intervals in multivariate analysis largely because a comprehensive set of tables and easy instructions were not available. This present report is a partial attempt to fill this gap. In this paper, testing procedures for three tests in multivariate analysis are given, and for two of the test situations which require the distribution of the largest characteristic root, numerical examples are worked out. Charts of the upper 1%, 2.5%, and 5% points of this distribution for the degrees of freedom $s = 2(1)5$, $m = -\frac{1}{2}, 0(1)10$, and $5 \leq n \leq 1000$ are included, as well as a procedure for obtaining the points for $n \geq 1000$. The method used in computing the percentage points is also described. (Contractor's abstract)

NCU.04:046

North Carolina U. Inst. of Statistics, Chapel Hill.

A THIRD ORDER ROTATABLE DESIGN IN FOUR DIMENSIONS, by N. R. Draper. May 1958, 5p. incl. table. (Mimeograph series no. 198) (AFOSR-TN-58-484) (AF 18(600)83) AD 158292 Unclassified

Also published in Ann. Math. Stat., v. 31: 875-877, Dec. 1960.

A model is presented for a third order design in 4 dimensions. The design requires 96 points and is a combination of 4 second order rotatable designs, permitting

NCU.04:047 - NCU.04:050

sequential performance in a number of ways. The design may be performed in 4 blocks, each containing 24 different combinations of factor levels.

NCU.04:047

North Carolina U. Inst. of Statistics, Chapel Hill.

ASYMPTOTIC POWER AND INDEPENDENCE OF CERTAIN CLASSES OF TESTS ON CATEGORICAL DATA, by E. L. Diamond. April 1958, 1v. incl. table, refs. (Mimeograph series no. 196) (AFOSR-TN-58-549) (AF 18(600)83) AD 158386 Unclassified

The analysis of categorical data is studied so as to distinguish between the case in which the sample is assumed drawn from a single multinomial population and the case in which the sample is drawn from several independent multinomial populations. In the first case all marginal totals of the resulting table of data are stochastic variates. In the second case some marginals are fixed by the manner in which the sample is drawn while the rest are stochastic variates. The necessary careful definition of the hypothesis to be tested and its alternation is given. Two properties of the various types of tests are: (1) the asymptotic power of the test; and (2) the necessary and sufficient conditions for the asymptotic independence in probability of two tests of a given type, and these are found to be appropriate to the two sampling situations.

NCU.04:048

North Carolina U. Inst. of Statistics, Chapel Hill.

ROTATABLE DESIGNS OF SECOND AND THIRD ORDER IN THREE OR MORE DIMENSIONS, by R. C. Bose and N. R. Draper. May 1958, 131p. Incl. diagrs. tables. (Mimeograph series no. 197) (AFOSR-TN-58-550) (AF 18(600)83) AD 158367 Unclassified

An attempt is made to meet the need for second and third order designs in 3 or more factors. Several new construction methods for obtaining rotatable designs of second and third order in 3 and higher dimensions are presented. By use of these methods various infinite classes of designs are obtained, and all of the rotatable designs previously known are derivable as special cases of these classes. A general theorem providing the exact conditions under which a third order arrangement is nonsingular is presented. (ASTIA abstract)

NCU.04:049

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE CONSTRUCTION OF A CLASS OF ERROR-CORRECTING BINARY SIGNALING CODES, by R. C.

Bose and R. R. Kuebler, Jr. May 1958, 173p. incl. diagrs. tables. (Mimeograph series no. 199) (AFOSR-TN-58-551) (AF 18(600)83) AD 158368 Unclassified

The nature of the group alphabet required to encode information for errorless (up to a point) transmission is discussed. The algebra is a commutative ring algebra whose elements are the 2^n distinct binary sequences of length n . Addition is vector addition, modulo 2, of sequences. Multiplication is specified by defining the i th coordinate of a product as the product, modulo 2, of the i th coordinate of the factors. The geometry employs 2 fundamental spaces: a topological space of n distinct points Y_i where the i th point corresponds to the i th position in an n -place binary sequence, and the finite projective space $PG(k-1, 2)$ from whose points the Y_i 's are selected. The space Ω is determined, to within ordering of points, by the assignment of measure n_i to the points P_i of $PG(k-1, 2)$, where n_i is the number of times P_i appears in Ω and $\sum_i n_i = n$. This distribution of n -measure is discussed, and it is shown that the distribution of n -measure over the points of $PG(k-1, 2)$ is equivalent to the distribution of a D -measure over the $(K-2)$ -flats of $PG(k-1, 2)$. Necessary and sufficient conditions are derived that a D -measure define a group alphabet which will admit the correction of all W -tuple errors in transmission. (ASTIA abstract)

NCU.04:050

North Carolina U. Inst. of Statistics, Chapel Hill.

PERCENTAGE POINTS OF WILK'S L_{mvc} AND L_{vc} CRITERIA, by J. Roy and V. K. Murthy. June 1958, 13p. Incl. tables. (Mimeograph series no. 200) (AFOSR-TN-58-553) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)83 and Office of Naval Research under Nonr-85506) AD 158371 Unclassified

Also published in Psychometrika, v. 25: 243-250, Sept. 1960.

An asymptotic series expansion is used to evaluate 5% and 1% points of the distribution of L_{mvc} and L_{vc} criteria for $p = 4, 5, 6, 7$ and $n = 25(5)60(10)100$. For higher values of n , a correction factor a is provided such that to a high degree of accuracy $(a-n)\log_e L_{mvc}$ or $(a-n)\log_e L_{vc}$ is distributed as chi-square. The use of the tables is illustrated with two numerical examples. A simple nonparametric alternative procedure is suggested for testing a generalization of the H_{mvc} hypothesis (the means are equal, the variances are equal, and the covariances are equal).

NCU.04:051 - NCU.04:055

NCU.04:051

North Carolina U. Inst. of Statistics, Chapel Hill.

A CLASS OF TWO REPLICATE INCOMPLETE BLOCK DESIGNS, by J. Roy. June 1958, 21p. incl. tables, refs. (Mimeograph series no. 201) (AFOSR-TN-58-554) (AF 18(600)83) AD 158372 Unclassified

Also published in Biometrics, v. 15: 259-269, June 1959.

A new class of two replicate designs called Simple Partially Linked Block designs is introduced. It is shown that with any of these designs, the variance of the estimate of the difference in effects of two treatments can be at most of seven different types. The general procedure of intra- and inter-block analysis is developed and illustrated with a numerical example. A list of these designs involving ten or fewer plots per block is given together with the values of parameters required in the analysis and the values of the efficiency-factor. It turns out that most of these designs are highly efficient with an efficiency-factor of the order of 75%. It is indicated how other two replicate designs can be derived from these designs. (Contractor's abstract)

NCU.04:052

North Carolina U. Inst. of Statistics, Chapel Hill.

THE UNIQUENESS OF THE L_2 ASSOCIATION SCHEME, by S. S. Shrikhande. June 1958, 25p. incl. refs. (Mimeograph series no. 204) (AFOSR-TN-58-608) (AF 18(600)83) AD 162136; PB 138971 Unclassified

Also published in Ann. Math. Stat., v. 30: 781-798, Sept. 1959.

The L_2 association scheme for a class of partially balanced incomplete block designs determines the parameters of the second kind. It is shown that the converse is true and that these parameters imply the L_2 association scheme in the case in which $s \geq 2$ and integral, $v = s^2$, $n_1 = 2s-2$, $p_{11}^1 = s-2$, and $p_{11}^2 = 2$. Necessary conditions for the existence of such designs are obtained if the above conditions hold and $s = 3$ and $s = 4$.

NCU.04:053

North Carolina U. Inst. of Statistics, Chapel Hill.

ON A CHARACTERIZATION OF THE TRIANGULAR ASSOCIATION SCHEME, by S. S. Shrikhande. July 1958, 15p. (Mimeograph series no. 206) (AFOSR-TN-58-609) (AF 18(600)83) AD 162137; PB 138977 Unclassified

Also published in Ann. Math. Stat., v. 30: 39-47, Mar. 1959.

A proof is given for the following theorem: A necessary and sufficient condition that a partially balanced incomplete block diagram for $n(n-1)/2$ treatments with 3 given parameters has triangular association scheme is that the first associates of any treatment whatsoever can be divided into 2 sets $(y_1, y_2, \dots, y_{n-2})$ and $(z_1, z_2, \dots, z_{n-2})$ such that $(y_i, y_j) = (z_i, z_j) = 1$ for $i \neq j = 1, 2, \dots, n-2$. The given parameters are (1) the number of first associates of any treatment is $n_1 = 2n-4$, (2) with respect to any 2 treatments θ_1 and θ_2 which are first associates (denoted by $(\theta_1, \theta_2) = 1$), the number of treatments which are first associates of both θ_1 and θ_2 is $p_{11}^1(\theta_1, \theta_2) = n-2$, and (3) with respect to any 2 treatments θ_3 and θ_4 which are second associates (denoted by $(\theta_3, \theta_4) = 2$), the number of treatments which are first associates of both θ_3, θ_4 is $p_{11}^2(\theta_3, \theta_4) = 4$. Two lemmas give the uniqueness of the triangular scheme for $n = 5$ and 6.

NCU.04:054

[North Carolina U. Inst. of Statistics, Chapel Hill].

[DESIGN OF EXPERIMENTS]. Final rept. Jan. 1, 1952-June 30, 1958 [8]p. (AF 18(600)83) Unclassified

The results of the research performed under this contract are summarized. Topics include the construction and properties of incomplete block designs, sequential methods in the analysis of variance and probit analysis, sequential design and decision problems, the use of order statistics for problems of ranking means, analysis and construction of paired comparison designs, designs for exploring response surfaces, construction of error correcting binary signaling codes, complex hypotheses on normal distributions, and simultaneous confidence interval estimation. Studies related to the analysis of variance include the generalization of all existing techniques of normal variate analysis of variance, covariance, and multivariate analysis, as well as studies of multivariate components of variance analysis and multivariate factor analysis. A list of technical notes and journal articles prepared under this contract is appended.

NCU.04:055

North Carolina U. Inst. of Statistics, Chapel Hill.

USEFUL BAYES SOLUTIONS FOR MULTIPLE COMPARISONS PROBLEMS, I (Abstract), by D. B. Duncan.

NCU.04:056; NCU.05:022, 023

Preliminary rept. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)83] and U. S. Public Health Service)

Unclassified

Presented at meeting of the Inst. of Math. Stat., Gatlinburg, Tenn., Apr. 10-12, 1958.

Published in Ann. Math. Stat., v. 29: 622-623, June 1958.

A Bayes solution is developed for the common t-test problem of testing the hypothesis $\theta \leq 0$ against the alternative $\theta > 0$ given observed values of x and s where x is normally distributed with θ as mean and variance σ^2 and s^2 is an independent estimate of σ^2 distributed as $x_p^2 \sigma^2 / \nu$. The ultimate objective is to solve many forms of multiple comparisons problems generated by the restricted products (Lehmann, Ann. Math. Stat., v. 28: 1-25, Mar. 1957) of problems of the given form, the Bayes solutions to be obtained as corresponding products of solutions of the form developed. The loss function assumes losses proportional to $|\theta|$, the factor for type I errors being k times that for type II errors, $k \geq 1$. The Bayes function is a normal density with mean 0 and variance $\gamma^2 \sigma^2$. These functions fit, at least to a satisfactory degree of approximation, a wide variety of problems met in practice. The solution (restricted to invariant procedures) has the critical region $x/s > t$ where t is a function of the degrees of freedom ν , loss ratio k and dispersion ratio γ^2 . A brief table of t with these three arguments is presented.

NCU.05:022

North Carolina U. Inst. of Statistics, Chapel Hill.

DISTINGUISHABILITY OF SETS OF DISTRIBUTIONS (THE CASE OF INDEPENDENT AND IDENTICALLY DISTRIBUTED CHANCE VARIABLES), by W. Hoeffding and J. Wolfowitz. Apr. 1957, 40p. incl. diagrs. tables. (Mimeograph series no. 166) (AFOSR-TN-57-154) (In cooperation with Cornell U., Ithaca, N. Y. under AF 18(600)685) (AF 18(600)458) AD 126446

Unclassified

Also published in Ann. Math. Stat., v. 29: 700-718, Sept. 1958.

Criteria are developed which determine whether for given sets of distributions \mathcal{F} , \mathcal{G} , and \mathcal{H} , there exists a test which makes the probability of an erroneous decision small when the distribution F belongs to \mathcal{G} or \mathcal{H} , and at the same time exercises some control over the number of observations required to reach a decision when F is in \mathcal{F} , and not only in \mathcal{G} or \mathcal{H} . Several classes of tests are considered such as the class of all fixed sample size tests, or the class of all tests which terminate with probability 1 whenever F is in \mathcal{F} . The distinguishability is studied of 2 sets of distributions in various classes of tests which are defined in terms of properties of the distribution of the sample size function N . Necessary and/or sufficient conditions are sought for the existence of a test in a given class which makes the maximum error probability in $\mathcal{G} \cup \mathcal{H}$ less than any preassigned positive number.

NCU.04:056

North Carolina U. [Inst. of Statistics] Chapel Hill.

ON THE LIMITING POWER FUNCTION OF THE FREQUENCY CHI-SQUARE TEST, by S. K. Mitra. [1958] [13]p. incl. table, refs. [AF 18(600)83] Unclassified

Published in Ann. Math. Stat., v. 29: 1221-1233, Dec. 1958.

A χ^2 statistic is considered for testing the hypothesis that in q independent, multinomially distributed random vectors the "cell" probabilities are given functions of several unknown parameters, asymptotically efficient estimators of which are used in the statistic. By a method similar to Cramer's [Mathematical methods of statistics, Princeton U. Press, Princeton, N. J., 1946] it is shown that if the true cell probabilities differ from the hypothetical ones by additive terms which suitably decrease to zero as the sample size increases, and regularity conditions analogous to Cramer's are satisfied, then the statistic has a limiting non-central chi-square distribution. The result is applied to two problems in the planning of experiments. (Math. Rev. abstract)

NCU.05:023

North Carolina U. Inst. of Statistics, Chapel Hill.

AN UPPER BOUND FOR THE VARIANCE OF CERTAIN STATISTICS, by W. Hoeffding. Mar. 1958, 12p. (Mimeograph series no. 193) (AFOSR-TN-58-243) (AF 18-(600)458) AD 154145

Unclassified

Presented at meeting of the Inst. of Math. Stat., Ames, Iowa, Apr. 3-5, 1958.

Abstract published in Ann. Math. Stat., v. 29: 620, June 1958.

The following bound is demonstrated:

$$r - p^2 \leq H(p) = \begin{cases} p^{3/2} - p^2, & p \geq 1/2 \\ (1-p)^{3/2} - (1-p)^2, & p < 1/2 \end{cases}$$

The context is as follows: $r = E f(X_1, X_2) f(X_1, X_3)$
 $p = E f(X_1, X_2)$. X_1, X_2, \dots, X_n are independent and

NCU.05:024, 025; NCU.06:001, 002

identically distributed random variables, and $f(X_1, X_2)$ is a bounded function such that $f(X_1, X_2) = f(X_2, X_1)$, $0 \leq f(X_1, X_2) \leq 1$.

NCU.05:024

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE PROBABILITY OF LARGE DEVIATIONS OF RANDOM VARIABLES, by I. N. Sanov, tr. by D. E. A. Quade. Mar. 1958, 50p. incl. diagrs. (Mimeograph series no. 192) (AF 18(600)458 and AF 18(600)83) AD 154161 Unclassified

Also published in *Matematicheskii Sbornik*, v. 42: 11-44, 1957.

A series of theorems are presented of which the following two are typical: Given an experiment having n mutually exclusive and exhaustive outcomes. Let p_i ($i = 1, \dots, n$) be the probability of the i th outcome, v_i , its relative frequency in N independent repetitions of the experiment. Let Ω be a closed set of points of the simplex $x_1 + \dots + x_n = 1$, $x_i \geq 0$, (satisfying some slight further condition specified in the paper). Then asymptotically

$$P\{(v_1, \dots, v_n) \in \Omega\} = \exp N \left[\sum_{i=1}^n \lambda_i \ln(p_i/\lambda_i) + O(1) \right],$$

where $(\lambda_1, \dots, \lambda_n)$ denotes the point in Ω at which $\sum_{i=1}^n x_i \ln(p_i/x_i)$ obtains its maximum, $(x_1, \dots, x_n) \in \Omega$, (Theorem 2). Let $F_N(x)$ be the empirical distribution function of a random sample of size N from a population with distribution function $F(x)$. Let $\Phi(x)$ be another distribution function hat $\int_{-\infty}^{\infty} \ln(dF/d\Phi)d\Phi$ exists. Then

$$\lim_{N \rightarrow \infty} \lim_{\epsilon \rightarrow 0} N^{-1} [\ln P \{ \sup_x |F_N(x) - \Phi(x)| < \epsilon \}] = \int_{-\infty}^{\infty} \ln(dF/d\Phi)d\Phi,$$

(Theorem 13). The paper concludes with some indications of the applicability of the given theorems to the solution of known problems. (Math. Rev. abstract)

NCU.05:025

North Carolina U. Inst. of Statistics, Chapel Hill.

DISTRIBUTION OF LINEAR CONTRASTS OF ORDER STATISTICS, by J. St. Pierre. [1958] [5]p. incl. tables. [AF 18(600)458] Unclassified

Published in *Ann. Math. Stat.*, v. 29: 1264-1268, Dec. 1958.

Let X_0, X_1, \dots, X_n be $n+1$ independent normal random variables with constant variance and expectations $\mu_0, \mu_1, \mu_2, \dots, \mu_n$ respectively. If $X_{(0)} \geq X_{(1)} \geq \dots \geq X_{(n)}$ are the corresponding order statistics, then a linear contrast of these order statistics is defined by

$$Z = X_{(0)} - \sum_{i=1}^n c_i X_{(i)}, \quad \sum_{i=1}^n c_i = 1, \quad 0 \leq c_i \leq 1 \quad (i = 1, \dots, n).$$

Formulas and/or tables for the probability density of Z are obtained in the case of $n = 2$ under the hypotheses: $H_0: \mu_0 = \mu_1 = \mu_2 = 0$; $H_1: \mu_0 = \delta, \mu_1 = \mu_2 = 0$ ($\delta > 0$); and $H_2: \mu_0 = 2, \mu_1 = 1, \mu_2 = 0$. (Math. Rev. abstract)

NCU.06:001

North Carolina U. Inst. of Statistics, Chapel Hill.

RELATION BETWEEN CERTAIN INCOMPLETE BLOCK DESIGNS, by S. S. Shrikhande. July 1958, 14p. incl. refs. (Mimeograph series no. 207) (AFOSR-TN-58-699) (AF 49(638)213) AD 162233; PB 140632 Unclassified

Also published in *Contributions to Probability and Statistics*, Stanford U. Press, Stanford, Calif., 1960, p. 388-395.

Relations have been established between various balanced incomplete block designs derived from symmetric balanced incomplete block designs with $\lambda = 1, 2$ and certain partially balanced incomplete block designs.

NCU.06:002

North Carolina U. Inst. of Statistics, Chapel Hill.

ANALYSIS OF VARIANCE WITH UNIVARIATE OR MULTIVARIATE, FIXED OR MIXED CLASSICAL MODELS, by S. N. Roy and J. Roy. Aug. 1958, 1v. in. 1. diagrs. tables. (Mimeograph series no. 208) (AFOSR-TN-58-850) (AF 49(638)213) AD 203491; PB 140676 Unclassified

A unified and general theory of univariate analysis of variance is applied to the multivariate case. Both univariate and multivariate (MANOVA) cases with fixed "effects" are elaborated with reference to the main classes of problems like analysis of variance, analysis of covariance and analysis of regression under general designs. The development is made on the basis of linear estimation and the use of least squares. Relevant theorems and results in vector spaces and matrix theory are stated, computational techniques are discussed and a set of charts is given as an appendix at the end as needed for both (model I) MANOVA and several problems on (model II and mixed models) MANOVA.

NCU.06:003; NOR.04:001;
NOR.05:001, 002; NOR.02:003

NCU.06:003

North Carolina U. [Inst. of Statistics] Chapel Hill.

ANALYSIS OF VARIANCE WITH UNIVARIATE OR MULTIVARIATE, FIXED OR MIXED CLASSICAL MODELS, SUPPLEMENT, by S. N. Roy and J. Roy. [1958] [14]p. (Mimeograph series no. 208, suppl.) (AFOSR-TN-58-850a) (AF 49(638)213) AD 214485
Unclassified

The analysis of variance with mixed classical models

is developed from $\underline{x} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}$ a set of n observable

random variables, which can be expressed as $\underline{x} = \underline{A}_0 \underline{\theta}_0 + \underline{A}_1 \underline{\theta}_1 + \dots + \underline{A}_k \underline{\theta}_k + \underline{\epsilon}$, where \underline{A}_i ($n \times m_i$),

$i = 0, 1, 2, \dots, k$ are matrices of known constants, $\underline{\theta}_i$ ($m_i \times 1$) is a vector of unknown parameters and

$\underline{\epsilon}$ ($n \times 1$), $i = 1, 2, \dots, k$, and $\underline{\epsilon}$ ($n \times 1$) are mutually independent random vectors with a normal distribution. Various testing techniques and hypotheses are developed.

NOR.04:001

Northwestern U., Evanston, Ill.

PROCEEDINGS OF THE SECOND BIENNIAL GAS DYNAMICS SYMPOSIUM ON TRANSPORT PROPERTIES IN GASES, Evanston, Ill. (Aug. 26-28, 1957), ed. by A. B. Cambel and J. B. Fenn. Evanston, Northwestern U. Press, Jan. 1958, 182p. incl. diagrs. tables, refs. (In cooperation with Amer. Rocket Soc.) (AFOSR-TR-58-22) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)211, Office of Ordnance Research, and Office of Naval Research (Project SQUID))
Unclassified

Twenty papers were presented at this symposium, which had as its specialized theme the subject of "Transport Properties in Gases". The objectives of the symposium were: (1) to define the state of the art in both theory and experiment for the determination of the transport properties of gases, with particular reference to extreme conditions; (2) to indicate the necessary data for application, design, and the advance of pure science; and (3) to point up promising avenues of future research of theoretical and experimental nature.

NOR.05:001

Northwestern U. [Dept. of Chemistry] Evanston, Ill.

ISOTOPIC EXCHANGE BETWEEN ALKANES AND

DEUTERIUM ON CHROMIUM OXIDE GEL CATALYST (Abstract), by A. B. Littlewood and R. L. Burwell, Jr. [1957] [1]p. [AF 18(603)132]
Unclassified

Presented at meeting of the Petrol. Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Published in 131st meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 16-Q.

Chromium oxide gel catalyzes isotopic exchange between alkanes and deuterium at temperatures of 200°C and above. Unlike the case with metallic catalysts, each adsorption step leads to the exchange of but a single atom of hydrogen. The catalyst becomes active only upon heating to 300°. Maximum activity develops upon increase in the pretreatment temperature to 470°. During this temperature increase, the activation energy of the exchange reaction remains at 16 kcal, but the surface area declines slightly. Hence active sites are being generated.

NOR.05:002

Northwestern U. Dept. of Chemistry, Evanston, Ill.

3,3-DIMETHYL-1,4-PENTADIENE, by R. L. Burwell, Jr. and R. Ciola. Dec. 31, 1957, 3p. (AFOSR-TN-58-16) (AF 18(603)132) AD 148055
Unclassified

Also published in Jour. Org. Chem., v. 23: 1063, July 1958.

The catalytic hydrogenation of 3,3-dimethyl-1,4-pentadiene was studied. A mixture of 0.5 mol of 1,5-dichloro-3,3-dimethylpentane, 2 mol of 2-methylquinoline and 0.1 mol of NaI was refluxed in a flask surmounted by a tubing 40 cm long with a standard taper plug at the top. The reflux rate was maintained so that the temperature at the top of the Vigreux column was between 60° and 70°C. The entire reaction required about 8 hr. The product was dried with Na_2SO_4 and fractionated; the yield was 58% at bp = 70.2°C at 750.5 mm. Further possible purification was effected by storage over Na and azeotropic distillation with methanol, n_D^{20} 1.4067; d_4^{20} 0.7017. 3,3-Dimethyl-1-pentene was made in 88% yield from 1-chloro-3, 3-dimethylpentane by the same process (bp = 77.2°C at 755 mm).

NOR.03:003

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

HOMOTOPY GROUPS OF ONE-DIMENSIONAL SPACES, by M. L. Curtis and M. K. Fort, Jr. [1957] [3]p. (AF 18-(600)1571)
Unclassified

Published in Proc. Amer. Math. Soc., v. 8: 577-579, June 1957.

NOR.02:004 - NOR.02:007

The authors prove that, if S is a one-dimensional separable metric space, then $\pi_k(S) = 0$ for $k > 1$. This is a generalization of the classical result, where S is a one-dimensional complex. Actually the following stronger theorem is obtained: Let X be a locally connected continuum whose one-dimensional integral singular homology group is a torsion group. Let S be a one-dimensional separable metric space. Then any map $f: X \rightarrow S$ is null-homotopic. (Math. Rev. abstract)

NOR.02:004

[Northwestern U. Dept. of Mathematics] Evanston, Ill.

AN IMBEDDING THEOREM, by M. L. Curtis. [1957]
[13]p. (AF 18(600)1571) Unclassified

Published in Duke Math. Jour., v. 24: 349-351, Sept. 1957.

Although it was known from joint work of the author and the reviewer that a 3-dimensional generalized closed manifold (i.e., 3-gcm) which (1) is imbeddable in E^4 , or (2) satisfies certain local homotopy conditions suggested by Griffiths [Mich. Math. Jour., v. 2: 61-89, 1954] is not necessarily a topological manifold in the classical sense, it was not known whether a 3-gcm which satisfies both (1) and (2) must be a topological manifold. The present paper shows that the answer is still negative, in that a quotient space of the 3-sphere given by Bing [paper reviewed second above], which satisfies condition (2) and is not locally euclidean, is imbeddable in E^4 . (Math. Rev. abstract)

NOR.02:005

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

A NOTE ON DERIVATIONS AND DIFFERENTIALS ON ALGEBRAIC VARIETIES, by M. Rosenlicht. [1957]
[13]p. (AF 18(600)1571) Unclassified

Published in Portugal. Math., v. 16: 43-55, 1957.

For most of this paper, the author sums up known results on derivations, differentials, local derivations and local differentials on algebraic varieties and group varieties. In the final paragraph, letting P be a simple rational point over K of an algebraic variety V defined over k , the author defines a differential $\omega(P)$ of K over k by $D \sim \omega_p(D_p)$, where D is a derivation of K over k , and D_p, ω_p are a local derivation and a local differential of V at P (D_p is the one which is induced by D). Then he shows that, when V is a commutative algebraic group variety, $\omega(PQ) = \omega(P) + \omega(Q)$. (Math. Rev. abstract)

NOR.02:006

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

ASYMPTOTIC DISTRIBUTIONS ASSOCIATED WITH THE LAPLACIAN FOR FORMS, by M. P. Gaffney. Feb. 1958, 12p. (AFOSR-TN-58-144) (AF 18(600)1571) AD 152171 Unclassified

Also published in Communications on Pure and Appl. Math., v. 11: 535-545, 1958.

Let M be a compact, n -dimensional, Riemannian manifold of class C^∞ . The author investigates the asymptotic distribution of the characteristic forms and values of the Laplace-Betrami operator $\Delta = d\delta + \delta d$ which acts on p -forms on M . The method used is to study the heat operator $\Delta + \partial/\partial t$. The fundamental solution of the heat equation is given in terms of the characteristic p -forms ω_i of Δ by

$$\theta(P, Q; t) = \sum_{i=1}^{\infty} \omega_i(P) \omega_i(Q) e^{-\lambda_i t},$$

where the λ_i are characteristic values of Δ . The author finds the asymptotic behavior of θ and, by applying Karamata's Tauberian theorem, he obtains the following asymptotic distributions:

$$\lambda_k \sim 4\pi \left[\frac{\Gamma(\frac{1}{2}n + 1)k}{\binom{n}{p} V} \right]^{2/n}, \quad \sum_{k=1}^k |\omega_k(P)|^2 \sim K/V.$$

NOR.02:007

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

THE CONSERVATION PROPERTY OF THE HEAT EQUATION ON RIEMANNIAN MANIFOLDS, by M. P. Gaffney. Feb. 1958, 12p. (AFOSR-TN-58-145) (AF 18(600)1571) AD 152172 Unclassified

Also published in Communications on Pure and Appl. Math., v. 12: 1-11, Feb. 1959.

Let M be a Riemannian manifold, $P \in M$ and let r be the distance from P . If M has the property that $e^{-\alpha r}$ is integrable on M for all positive α , then the author proves the following conservation property. Let u be a solution of the heat equation $\delta_c k d'u = -\sigma (\partial u / \partial t)$ with a compact carried initial function f . Then $\int_M u \sigma dV = \int_M f \sigma dV$ for all t . In the above δ_c denotes the negative of the divergence operator restricted to C^1 forms with compact carriers, d' is the Hilbert space adjoint of δ_c and $\bar{\delta}_c$ is the closure of δ_c . (Math. Rev. abstract)

NOR. 02:008; NOR. 06:001-003

NOR.02:008

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

EXTENSIONS OF VECTOR GROUPS BY ABELIAN VARIETIES, by M. Rosenlicht. [1958] [30]p. incl. refs. (AF 18(600)1571) Unclassified

Published in Amer. Jour. Math., v. 80: 885-714, July 1958.

The author develops the theory of simple differentials of the second kind on an algebraic variety by studying the set of all abelian group extensions of direct products of additive groups over a given abelian variety. The set of equivalence classes of extensions of the additive group of one dimension by a given variety A has the structure of a vector space. The chief results of the paper, established in theorems 1 and 3, are that this vector space has the same dimension as A and is isomorphic to the cohomology space $(H^1(A, O_A))$, in which O_A is the sheaf of local rings on A . All of the methods used are purely algebraic, except in the part of proposition 11 dealing with the case of characteristic zero. (Math. Rev. abstract)

NOR.06:001

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

PRINCIPAL SOLUTIONS OF NON-OSCILLATORY SELF-ADJOINT LINEAR DIFFERENTIAL SYSTEMS, by W. T. Reid. Aug. 1957, 28p. refs. (Technical rept. no. 1) (AFOSR-TN-57-485) (AF 18(603)88) AD 136456 Unclassified

Also published in Pacific Jour. Math., v. 8: 147-169, Spring 1958.

A generalized definition is presented of the principal solution for a general self-adjoint vector differential equation which is nonoscillatory for large values of the independent variable. Principal solutions are shown to possess certain properties on Γ_0 , the class of all matrix solutions which are nonsingular for large values of the independent variable, which are extensions of properties established by Hartman (Duke Math. Jour., v. 24: 25-35, 1957) for a certain class of solutions, Γ . The principal solution is determined by variational methods and is direct in nature. A discussion is presented of a self-adjoint n -dimensional vector equation with complex coefficients which is a direct generalization of the Euler scalar equation. A general differential system with complex coefficients is treated which is of the general form of the accessory differential equations for a variational problem of the Bolza type.

NOR.08:002

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

A CLASS OF TWO-POINT BOUNDARY PROBLEMS, by W. T. Reid. Sept. 1957, 27p. incl. refs. (Technical rept. no. 2) (AFOSR-TN-57-550) (AF 18(603)88) AD 136534 Unclassified

Also published in Illinois Jour. Math., v. 2: 434-453, Sept. 1958.

A previous analysis is extended of the various conditions satisfied by systems which are self-adjoint and definite in the sense of either Bliss or Reid. Consideration is given of a system of the general form

$$A_1(x)y' + A_0(x)y = \lambda B(x)y, \quad a \leq x \leq b, \quad My(a) + Ny(b) = 0$$

with $A_1(x)$ non-singular on ab : $a \leq x \leq b$. In terms of a

non-singular transformation $z(x) = T(x)y(x)$, $a \leq x \leq b$, the conditions for the system corresponding to Bliss are as follows: (1) the system is equivalent to its adjoint under the transformation; (2) $S(x) = T^*(x)B(x)$ is Hermitian on ab ; (3) $S(x)$ is non-negative definite on ab ; and (4) if $A_1y' + A_0y = 0$, $My(a) - Ny(b) = 0$, and $By \neq 0$, then $y = 0$ on ab . Reid's conditions are the same as 1, 2, and 4, while 3 is replaced by the condition that

$$\int_a^b y^* T^* [A_1 y' + A_0 y] dx \text{ is positive for arbitrary } y(x)$$

a

satisfying $My(a) - Ny(b) = 0$, $By \neq 0$ and for which there is an associated vector function $g(x)$ such that $A_1 y' + A_0 y = Bg$. The conditions are discussed and applied. The results are compared to others in literature. A simple method is devised to treat abnormal problems. (ASTIA abstract)

NOR.06:003

Northwestern U. Dept. of Mathematics, Evanston, Ill.

GENERALIZED LINEAR DIFFERENTIAL SYSTEMS, by W. T. Reid. Sept. 1958, 30p. incl. refs. (Technical rept. no. 3) (AFOSR-TN-58-873) (AF 18(603)88) AD 203915; PB 142295 Unclassified

Also published in Jour. Math. and Mech., v. 8: 705-726, Sept. 1950.

The generalized differential system treated is equivalent to a type of linear vector Riemann-Stieltjes integral equation and includes, as special instances, certain differential systems with interface conditions at a finite number of points. An existence theorem and related properties of solutions are considered. For self-adjoint systems, the existence of criteria for oscillation and non-oscillation that are direct generalizations of known criteria for the usual self-adjoint differential system is

NOR.07:001 - NOR.07:002

shown. Such systems are extended to the oscillation, separation, and comparison theorems occurring in the Morse generalization of the classical Sturmian theory. The extension of the results on principal solutions are considered. Also considered is a system of second order difference equations that occurs as a special instance of the general system. (ASTIA abstract)

NOR.07:001

[Northwestern U. Dept. of Mathematics] Evanston, Ill.

[SIMPLE LIE ALGEBRAS ASSOCIATED WITH SIMPLE ALGEBRAIC GROUPS OVER A FIELD OF CHARACTERISTIC $p > 0$] Les algèbres de Lie simples associées aux groupes simple algébriques sur un corps de caractéristique $p > 0$, by J. Dieudonné. [1957] [7]p. (AF 49(638)106) Unclassified

Published in Rend. Circ. Matem. Palermo, Series II, v. 6: 198-204, May-Aug. 1957.

Let g be a simple finite dimensional Lie algebra over the field of the complex numbers. A normalized basis for g , in the sense of Chevalley (Tohoku Math. Jour., v. 7: 14-66, 1955), for which the multiplication table is integral, yields a Lie algebra g^* over the ring Z of the rational integers (having for a basis a normalized basis of g), and g^* is determined up to an isomorphism by g . Hence, if K is any field, of arbitrary characteristic, one can invariantly associate with g a Lie algebra $g_K = g^* \otimes K$ over K . The question arises of how far these Lie algebras g_K are from being simple. For classes A, B, C, D of the classical simple Lie algebras g , the determination of the ideals and composition series of the g_K 's can easily be extracted from results of Jacobson (Amer. Jour. Math., v. 63: 481-515; Trans. Amer. Math. Soc., v. 50: 15-25, 1941). Here, this determination is accomplished for the five exceptional simple Lie algebras g by direct computation. The result is that g_K , with g exceptional and K arbitrary, is simple, except in the following cases: (1) g is of type G_2 and K is of characteristic 3; then g_K has only a single proper ideal u , which is of dimension 7, and the Lie algebras u and g_K/u are simple and isomorphic. (2) g is of type F_4 and K is of characteristic 2; then g_K has only a single proper ideal u , which is of dimension 26, and the Lie algebras u and g_K/u are simple and isomorphic. (3) g is of type E_6 and K is of characteristic 3; then the only proper ideal of g_K is its 1-dimensional center c , and g_K/c is simple. (4) g is of type E_7 and K is of characteristic 2; then the only proper ideal of g_K is its 1-dimensional center c , and g_K/c is simple. (Math. Rev. abstract)

NOR.07:002

[Northwestern U. Dept. of Mathematics] Evanston, Ill.

[LIE GROUPS AND LIE HYPERALGEBRAS OVER A FIELD OF CHARACTERISTIC $p > 0$ (VII)] Groupes de Lie et hyperalgèbres de Lie sur un corps de caractéristique $p > 0$ (VII), by J. Dieudonné. [1957] [20]p. (AF 49(638)106) Unclassified

Published in Math. Ann., v. 134: 114-133, Nov. 1957.

A complete classification is given, up to isogeny of formal abelian groups G of finite dimension over an algebraically closed field K of characteristic $p \neq 0$. The fundamental theorems are as follows. (1) G is isogeneous to a direct product of simple groups and Witt groups W_m . (2) A simple group G is isogeneous to one of the groups $G_{n,0,m}$, where m and n are coprime. (3) The ring of endomorphisms of the simple group $G_{n,0,m}$

is isomorphic to an order in the central division algebra of rank $(m+n)^2$ and invariant $n/(m+n)$ over the field of p -adic numbers. The author associates with G a matrix $M(G)$ whose coefficients lie in a certain non-commutative ring \mathbb{G}^+ ; moreover, G_1 and G_2 are isomorphic if, and only if $M(G_1)$ and $M(G_2)$ are equivalent over \mathbb{G}^+ . It is proved in that G_1 and G_2 are isogeneous if, and only if, $M(G_1)$ and $M(G_2)$ are equivalent over a certain

ring \mathcal{U} which contains \mathbb{G}^+ . \mathbb{G}^+ are defined as follows. Let W denote the ring of Witt vectors $A = (a_0, a_1, \dots)$ over K ; W is a complete valuation ring, $\pi = (0, 1, 0, \dots)$ a uniformizing parameter, and the mapping $A \rightarrow A^\sigma = (a_0^\sigma, a_1^\sigma, \dots)$ an automorphism of W . Then \mathbb{G}^+ is the set of all formal non-commutative integral power series $A_0 + tA_1 + t^2A_2 + \dots$, where the $A_i \in W$ and the indeterminate t satisfies $At = tA^\sigma$ for all $A \in W$. \mathcal{U} is the set of all power series $t^h A_h + t^{h+1} A_{h+1} + \dots$ ($h = 0, \pm 1, \pm 2, \dots$). It is proved that (i) \mathcal{U} has a Euclidean division algorithm and (ii) the \mathcal{U} -modules which intervene are all bounded (i.e., they have non-zero annihilator). (i) enables the powerful theory of modules over principal ideal rings to be applied and (ii) allows a further reduction to problems of similarity, etc., within \mathcal{U} itself. It is also shown that each $u \in \mathcal{U}$ can be written in 'quasi-normal' form $u = \pi^r \sigma_1^s \sigma_2^t \dots \sigma_n^r \tau_1^s \tau_2^t \dots \tau_n^r$, where the u_i are invertible elements of \mathbb{G}^+ , the σ_i form a strictly decreasing sequence of integers ≥ 0 , and the τ_i a strictly increasing sequence of integers. Finally, an infinity of formal abelian groups of dimension 2 are constructed,

NOR.07:003 - NOR.07:004

any two of which are isogeneous but no two of which are isomorphic. This (and other evidence) suggests that the classification of abelian groups up to isomorphism may be difficult. (Math. Rev. abstract)

NOR.07:003

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

[REMARKS ON THE REDUCTION MOD. p OF THE LINEAR ALGEBRAIC GROUPS] Remarques sur la réduction mod. p des groupes linéaires algébriques, by J. Dieudonné. [1958] [8]p. (AF 49(638)106)

Unclassified

Published in Osaka Math. Jour., v. 10: 75-82, June 1958.

Making use of the theory of hyperalgebras of Lie the results of T. Ono are extended to the case of a body of perfect base with arbitrary characteristics.

NOR.07:004

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

LIE GROUPS AND LIE HYPERALGEBRAS OVER A FIELD OF CHARACTERISTIC $p > 0$ (VIII), by J. Dieudonné. [1958] [33]p. (AF 49(638)106)

Unclassified

Published in Amer. Jour. Math., v. 80: 740-772, July 1958.

In the present paper the author initiates the study of group extensions. (Unless otherwise stated, 'group' will always mean 'formal Lie group of finite dimension over an algebraically closed field K of characteristic $p \neq 0$.) The basic concepts are the factor group H/N and natural homomorphism $h: H \rightarrow H/N$ corresponding to a normal 'typical' subgroup N of the group H ; the definition given here is more direct than that in part VI and avoids the hyperalgebra. A sequence of groups and homomorphisms $0 \rightarrow A \xrightarrow{u} P \xrightarrow{v} G \rightarrow 0$ is called exact if it can be carried by isomorphisms into a sequence $0 \rightarrow N \xrightarrow{j} H \xrightarrow{h} H/N \rightarrow 0$ (N typical, j the natural injection), and such an exact sequence defines an extension (P, u, v) of G by A . Equivalence of extensions is defined in the usual way. In non-formal group theory a splitting extension of G by A gives rise to a 'semi-direct' product $P \rtimes A$; once the mode of action of A on P has been fixed, the semi-direct product can be defined abstractly as the set of pairs (g, a) ($g \in G, a \in A$) under a certain law of multiplication. The author gives an analogous abstract definition of a semi-direct product of formal groups G, A , and the corresponding extension of G by A is called trivial. It is pointed out that (P, u, v) is not necessarily trivial when P contains a subgroup G' isomorphic to G and such that $u(A) \cap G' = e$, $u(A) \cap G' =$

$P(A, v)$ are defined in part VI); these conditions ensure merely that P is isogeneous to a semi-direct product of G and A . When G acts trivially on A , the semi-direct product becomes the direct product $G \times A$. A group H is called quasi-direct product of its normal subgroups M, N if $M \cap N = e$, $M \vee N = H$; H is then isogeneous, but not necessarily isomorphic, to $M \times N$ and the corresponding extension of M by N is called quasi-trivial. The main result of this paper is theorem A: Every solvable group is isogeneous to a direct product $P \rtimes Q$, where D is a divisible abelian group and Q a semi-direct product of the largest unipotent subgroup of P and a torus. Theorem A follows readily from results in VI and theorem B: If P is a solvable group and D the largest divisible abelian group in the center of P , then D is a quasi-direct factor of P . For the proof of theorem B, the author introduces formal G -modules and their (non-formal) cohomology groups. Let G be a group, A an abelian group, with respective laws of composition $st = (\phi_i(s, t))_{i \in I}$, $x + y = (\psi_j(x, y))_{j \in J}$. Then A becomes a G -module if we prescribe a system of power series $s \cdot x = (f_j(s, x))_{j \in J}$, without constant terms, such that (i) $s \cdot (x + y) = s \cdot x + s \cdot y$; (ii) $e \cdot x = x$; (iii) $s \cdot (t \cdot x) = (st) \cdot x$. An m -cochain is defined as a system of power series $g(s_1, \dots, s_m) = (g_j(s_1, \dots, s_m))_{j \in J}$, without constant terms, in m independent sets $s_h = (s_{hi})_{i \in I}$ of variables ($1 \leq h \leq m$). Sum of cochains, coboundary, cohomology groups $H^m(G, A)$ are now defined in an evident way. A difficulty arises, however, in defining 1-coboundaries because there are no 'elements' in A ; $H^1(G, A)$ is identified with the group of homomorphisms of G into A when G acts trivially on A and is left undefined otherwise. The usual correspondence between elements of $H^2(G, A)$ and classes of equivalent extensions of G by A holds good, and the zero of $H^2(G, A)$ corresponds to the trivial extensions as defined above. The principal tool in proving theorem B is the lemma: Suppose that the group G and its subgroups and factor groups act trivially on the abelian group A and let H be a normal subgroup of G such that $H^1(H_1, A_1) = 0$ for any perfect extension 1 of the field K (H_1, A_1 are the groups over 1 , defined by the same systems of power series as H, A); then there exists an exact sequence $0 \rightarrow H^2(G/H, A) \rightarrow H^2(G, A) \rightarrow H^2(H, A)$. The proof is not easy and depends on the construction of an auxiliary G -module of infinite dimension. To complete the proof of theorem B, the author shows, using part VI, that there is a sequence of subgroups of the solvable group $P: D \subset R_1 \subset R_2 \subset \dots \subset R_m \subset P$, each normal in its successor, such that R_1 is the center of P , R_{i+1}/R_i is isomorphic to the additive group I_n of K for $1 \leq i \leq m-1$, and P/R_m is a torus T . After showing independently that all central extensions of I_n or T by D are quasi-trivial, he applies a modified form of the lemma to obtain the

NOR.07:005; NOR.08:001, 002

theorem by induction. As an application, all 2-dimensional groups are determined up to isogeny. The 2-dimensional nilpotent groups G , with laws of composition of the form

$$\begin{aligned}\phi_1(x, y; x', y') &= x + x', \\ \phi_2(x, y; x', y') &= y + y' + f(x, x'),\end{aligned}$$

provide interesting examples. Firstly, if $f(x, x') = \sum_{h,k} e_{hk} x^h x'^k$ and the e_{hk} are algebraically independent over the prime field F_p of K , then G is a noncommutative unipotent group which is not representable (i.e., not isogeneous to a subgroup of a full linear group). Secondly, if $f(x, x') = \sum_{h \geq 1} e_h x^h x'$ and the e_h are algebraically independent over F_p , then G is isogeneous to a subgroup of $GL(3)$ but not to any algebraic group. (Math. Rev. abstract)

NOR.07:005

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

[ON THE PARAMETRIC REPRESENTATION OF CAYLEY] Sur la représentation paramétrique de Cayley, by J. Dieudonné. [1958] [3]p. [AF 49(638)106] Unclassified

Published in Arch. der Math., v. 9: 39-41, 1958.

The author extends the Cayley parametrization to classical groups over division rings of characteristic 2. (1) Let K be a division ring of arbitrary characteristic, J an involutory anti-automorphism of K , A an $n \times n$ nonsingular Hermitian matrix over K of the form $C + {}^t C^J$. Then the equation $U = ({}^t C^J - S)^{-1}(C + S)$ gives a one-one correspondence between non-exceptional unitary matrices $U ({}^t U^J A U = A, I + U \text{ non-singular})$ and skew-Hermitian matrices S such that $C + S$ is non-singular. (2) Similarly, if K is commutative,

$$A = \begin{pmatrix} 0 & I_n \\ -I_m & 0 \end{pmatrix} \text{ and } C = \begin{pmatrix} 0 & I_m \\ 0 & 0 \end{pmatrix}, \text{ the formula}$$

$U = -({}^t C + S)^{-1}(C + S)$ gives a one-one correspondence between non-exceptional symplectic matrices U and symmetric matrices S such that $C + S$ is non-singular. (3) In (2), let K have characteristic 2. It is well known that every orthogonal matrix for the quadratic form

$$Q(x) = \sum_{i=1}^n x_i x_{m+i}$$

is a symplectic matrix for A . It is shown that conversely, a non-exceptional symplectic matrix $({}^t C + S)^{-1}(C + S)$ is orthogonal if, and only if, S is alternating, i.e., all diagonal elements of S are 0.

(1), (2) are proved by specializing a result on rings

with an involutory anti-automorphism and (3) is deduced by direct calculation. (Math. Rev. abstract)

NOR.08:001

Northwestern U. Dept. of Mathematics, Evanston, Ill.

MULTIPLE CONFIDENCE PROCEDURES, by M. Dwass. [1959] [6]p. Incl. table. (AFOSR-TN-57-783) (AF 49-638)151 AD 148014 Unclassified

Also published in Ann. Inst. Stat. Math. (Tokyo), v. 10: 277-282, 1959.

Suppose x_1, \dots, x_n is a set of independent variables having normal distributions $N(\mu_1, \sigma^2), \dots, N(\mu_n, \sigma^2)$ and let s^2 be a random variable independent of x_1, \dots, x_n such that ks^2/σ^2 has a chi-square distribution with k degrees of freedom. Let $\bar{x} = n^{-1} \sum_1 x_i$ and T_p be defined by

$$P\left(\sum_1 |x_i - \bar{x}|^p / k^{1/2} s > T_p\right) = \alpha$$

where $0 \leq p < \infty$ and $0 < \alpha < 1$. It is shown by using Hölder's inequality that the probability is $1 - \alpha$ that

$$\left| \sum_1 a_i \mu_i - \sum_1 a_i x_i \right| \leq \left[\sum_1 (a_i - \hat{a})^q \right]^{1/q} T_p$$

for all (real) vectors (a_1, \dots, a_n) satisfying $\sum_1 a_i = 0$, where $1/p + 1/q = 1$, and where \hat{a} satisfies

$$\sum_1 |a_i - \hat{a}|^q = \inf_c \sum_1 |a_i - c|^q.$$

Similarly, it is shown that the probability is $1 - \alpha$ that

$$\left| \sum_1 a_i \mu_i - \sum_1 a_i x_i \right| \leq \left(\sum_1 a_i^q \right)^{1/q} T_p$$

for all real vectors (a_1, \dots, a_n) satisfying $\sum_1 a_i = 0$, where T_p is defined by

$$P\left(\sum_1 |x_i - \hat{x}|^p / k^{1/2} s > T_p\right) = \alpha \text{ and}$$

$$\sum_1 |x_i - \hat{x}|^p = \inf_c \sum_1 |x_i - c|^p.$$

The author shows how various results on simultaneous confidence intervals previously obtained by Tukey, Scheffé, and by Bose and Roy reduce to special cases of these results. (Math. Rev. abstract)

NOR.08:002

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

ON SEVERAL STATISTICS RELATED TO EMPIRICAL DISTRIBUTION FUNCTIONS, by M. Dwass. [1957] [4]p. (AFOSR-TN-57-784) (AF 49(638)151) AD 148015 Unclassified

NOR.03:001, 002; NOR.03:004, 005

Also published in Ann. Math. Stat., v. 29: 188-191, Mar. 1958.

Let X_1, \dots, X_n be a sample of a random variable X with continuous conditional distribution function $F(x)$, and $F_n(x)$ the corresponding empirical conditional distribution function. Consider the random variables: $U_n = \mu \{F(t): F_n(t) - F(t) > 0\}$ where μ denotes Lebesgue measure; $D_n = \sup_t [F_n(t) - F(t)]$; $V_n = \inf_t [F(t): F_n(t) - F(t) = D_n]$. It is known that U_n and V_n have uniform probability distributions on $(0, 1)$ (B. V. Gnedenko and V. S. Mihalevic, Dokl. Akad. Nauk SSSR (N.S.) v. 85: 25-27, 1952; Z. W. Birnbaum and R. Pyke, Ann. Math. Stat., v. 29: 179-187, 1958.) Concise proof is given of these two statements, employing results of E. S. Andersen (Math. Scand., v. 1: 263-285, 1953) and known properties of the Poisson process, and generalization of them is made to the case where $F_n(t)$ is replaced by a weighted mean of several empirical distribution functions corresponding to independent samples of the same random variable. (Math. Rev. abstract)

NOR.09:001

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

ON HILBERT TRANSFORMS OF FUNCTIONS OF CLASS L' , by R. R. Goldberg. [1958] 5p. (AFOSR-TN-58-610) (AF 49(638)383) AD 162138; PB 139438
Unclassified

The similarity between the theory of Hilbert transforms with that of Fourier transforms is pointed out. A similar relationship is demonstrated between f , F , G , and g if $f \in L'$ where L' is used to denote $\int_{-\infty}^{\infty} |f(u)| du < \infty$. It is shown that if $f \in L'$ then the Hilbert transform of f exists almost everywhere.

NOR.09:002

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

CERTAIN OPERATORS AND FOURIER TRANSFORMS ON L^2 , by R. R. Goldberg. [Nov. 1958] 6p. (AFOSR-TN-58-1007) (AF 49(638)383) AD 206150; PB 139437
Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 385-390, June 1959.

A proof is presented of the following result for a wide class of functions f . If g is the cosine transform of

$f \in L^2$, then $G(x) = \frac{1}{x} \int_0^{\infty} \frac{y}{x} g(y) dy$ is the

cosine transform of $F(y) = \int_0^{\infty} \frac{1}{x} \psi\left(\frac{y}{x}\right) f(x) dx$. The

same result applies to sine transforms. Properties of a certain class of bounded operators on L^2 are developed. A class of self-adjoint bounded operators are constructed which commute with the Fourier cosine (or sine) transform.

NOR.03:004

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

APPARATUS FOR PRECISE DETERMINATION OF DYNAMIC YOUNG'S MODULUS AND INTERNAL FRICTION AT ELEVATED TEMPERATURES, by M. E. Fine. May 16, 1957 [11]p. incl. diagrs. refs. (AFOSR-TN-57-267) (AF 18(600)1468) AD 126566
Unclassified

Also published in Rev. Scient. Instruments, v. 28: 943-945, Aug. 1957.

The apparatus for the precise determination of dynamic Young's modulus and internal friction at elevated temperatures employs electrostatic excitation and detection of longitudinal vibrations in a rod. Several improvements over the Cabrat apparatus are incorporated which include a somewhat higher range of temperature, a smaller specimen, better precision, improved vacuum, and easier operation. The mechanical and electrical systems are described. Examples of data determined with the apparatus are presented. The internal friction of single crystals of Al determined with the apparatus agree quite well with determinations by the piezoelectric method. The upper temperature limit of the apparatus was the weakness of the signal due to internal friction of the sample rather than any breakdown of the apparatus. Operating temperatures up to 850°C are anticipated for the apparatus with a proper sample.

NOR.03:005

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

AN ACOUSTICAL STUDY OF LOW TEMPERATURE AGING IN Al - 4.2% Cu, by M. E. Fine and C. Chlou. Dec. 2, 1957 [21]p. incl. diagrs. refs. (AFOSR-TN-57-761) (AF 18(600)1468) AD 148013
Unclassified

Also published in Trans. Metallurgical Soc. of AIME, v. 212: 553-557, Aug. 1958.

While Guinier-Preston zones are growing in Al-4.2% Cu at room temperature, Young's modulus, measured dynamically, increases about 0.4%. From the change in modulus with time the exponent of time in the rate equation for growth of the zones was deduced to be 1/2. From a comparison of the rates of increase of modulus at 1, 28,

NOR.03:006 - NOR.03:009

and 42°C an activation energy of 12 to 14 kcal/mol is computed. These findings support the idea that Cu atoms are supplied along dislocation channels to growing zones. (Contractor's abstract)

NOR.03:006

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

THE STRENGTH OF AGE HARDENED ALLOYS
(Abstract), by A. Kelly. [1957] [2]p. (AF 18(600)1468)
Unclassified

Presented at meeting of the Metallurgical Soc. of Amer. Inst. Mining and Metall. Engineers, Chicago, Ill., Nov. 4-6, 1957.

Possible crystallographic structures produced during the aging of super-saturated solid solutions of Al-Cu and Al-Ag systems are investigated in order to determine what processes may contribute to the strength of an age hardened alloy. These two systems have been chosen since they have been most thoroughly studied using x-ray methods. The appearance of the various structures correlates very well with the various hardening stages. Stress-strain curves of single crystals of Al-Cu, aged by various amounts, are presented and the appearance of the slip lines discussed. A broad correlation is found between the slip line appearance and the type of stress-strain curve. An attempt is made to account for the strength of age hardened alloys at various stages of the aging sequence in terms of current theories. It is concluded that the overaged condition is the one best understood at present. Measurements of the temperature dependence of the flow stress seem to offer the simplest means of testing the various theories. An explanation of the strength of Al-Cu and Al-Ag alloys in the cold hardening stage is put forward which associates the flow stress with the work done in shearing the Guinier-Preston zones. Estimates of this may be made from the heats of reversion. The calculated flow stresses are in reasonable agreement with measured values.

NOR.03:007

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

THE TEMPERATURE DEPENDENCE OF THE FLOW STRESS OF AN AGE-HARDENED ALLOY, by A. Kelly and C. Chlou. [1958] [25]p. incl. diagrs. tables, refs. (AFOSR-TN-58-36) (AF 18(600)1468) AD 148075; PB 133458
Unclassified

Also published in Acta Metallurgica, v. 6: 565-571, Sept. 1958.

Measurements have been made of the critical resolved shear stress of single crystals of an aluminum - copper alloy between 77°K and 373°K. The crystals were aged

so that they contained only Guinier - Preston zones of the first kind. By changing the temperature during deformation of these crystals the reversible change of flow stress with temperature during deformation has also been measured. This reversible change of flow stress varies with temperature in a manner similar to that shown by pure aluminum crystals in that, after elimination of the variation of the elastic constants with temperature, it is approximately constant at temperatures above 160°K but increases at lower temperatures. From comparison between the results obtained from crystals containing GP zones and crystals "reverted" so that the zones are redissolved it is suggested that the temperature dependence of the flow stress is governed by some thermally activated process which enables the dislocations to avoid passing through the zones. The most likely process seems to be cross slip. (Contractor's abstract)

NOR.03:008

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

INTERNAL FRICTION AND YOUNG'S MODULUS OF HEXAGONAL AND CUBIC COBALT, by M. E. Fine and E. H. Greener. Feb. 6, 1958 [8]p. incl. diagrs. (AFOSR-TN-58-58) (AF 18(600)1468) AD 148099
Unclassified

Also published in Trans. Metall. Soc. AIME, v. 212: 476-478, Aug. 1958.

The internal friction and Young's modulus of cobalt has been measured by a dynamic electrostatic method in the temperature range from 25 to 600°C. Both quantities show a discontinuity near 400°C which is the point of the hexagonal-cubic phase transformation. The internal friction is plotted as a linear function of 1/T. An investigation of the dependence of the internal friction and modulus on strain amplitude showed no measurable change with a 10 fold increase in the driving voltage.

NOR.03:009

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

THE STRENGTH OF ALUMINUM SILVER ALLOYS, by A. Kelly. [1958] 5p. (AFOSR-TN-58-912) (AF 18(600)1468) AD 204568; PB 137847
Unclassified

Also published in Philosophical Mag., v. 3: 1472-1474, Dec. 1958.

Single crystals of aluminum - 6 atomic % silver quenched from the δ -phase field and aged at room temperature show a critical resolved shear stress at 0°C of 7-8 kg/mm².

NOR.03:010 - NOR.03:013

NOR.03:010

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

AN ACOUSTICAL STUDY OF LOW-TEMPERATURE AGE-HARDENING AFTER REVERSION IN Al - 6 at-% Ag, by H. Herman and M. E. Fine. Dec. 3, 1958 [20]p. incl. diagrs. table, refs. (AFOSR-TN-58-1025) [AF 18-(600)1468] AD 162292; PB 137941 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 218: 44-49, 1960.

A study was conducted to determine the kinetics of re-aging after reversion in single crystals and to determine the mechanism of growth of Guinier-Preston zones. Two Al-6 atomic % Ag single crystals, about 1.3 by 0.05 in. in size, were grown using a modified Bridgman technique from ingots. The specimens were homogenized for 1 month in a 550°C salt bath. For solution treatment, the specimen was contained in a sealed and weighted pyrex ampule evacuated to 10^{-6} mm Hg which was suspended by a wire in a vertical furnace. For the quench, the wire was cut, allowing the ampule to drop into 25° water. Aging to the fully hardened state was attained by a 42-hr treatment at 100°C. Reversion was accomplished by heating for 15 min at 220°C. Plots were made for the fractional change of the resonant frequency from the initial reading to time t for re-aging after reversion at 50°, 70°, and 100°C. The re-aging reactions at 70° and 100°C were completed while the 50°C re-aging curve was 60% complete after 160 hr. Young's modulus decreased during concentration of Ag atoms into zones, the rate decreasing with increasing aging time. Zone formation occurred while the specimens were being warmed to the re-aging temperature. The decrease in modulus for the completed re-aging reaction was 2 of 3%. The total change from $\frac{1}{2}$ hr to completion was less for direct aging than for re-aging after reversion. Curves obtained for a crystal re-aged for 2 hr at 70°C and dropped to 50°C were extrapolated to 2.5 hr and indicated a 10 ± 2 kcal/mol activation energy.

NOR.03:011

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

DEFORMATION OF SINGLE CRYSTALS CONTAINING GUINIER-PRESTON ZONES, by A. Kelly. Dec. 30, 1958, lv. incl. diagrs. tables, refs. (AFOSR-TN-58-1083) (AF 18(600)1468) AD 207530; PB 144852 Unclassified

Presented at Phys. Soc. Conf. on Internal Surfaces, Cambridge (GL Brit.), Dec. 17-19, 1958.

The results presented in this report are confined to single crystals of aluminum containing either copper or silver, in the early stages of aging. Under these conditions the precipitates are said to be "coherent"

with the matrix. The formation of a "coherent" precipitate is taken to mean the replacement of a given number of atoms of the solid solution by the same number of atoms of the precipitate, these being arranged on the same type of lattice as those of the matrix.

NOR.03:012

Northwestern U. [Dept. of Metallurgy] Evanston, Ill.

ACOUSTICAL STUDY OF G. P. ZONE FORMATION AFTER REVERSION IN Al-20 WT. PCT. Ag (Abstract), by H. Herman and M. E. Fine. [1958] [1]p. [AF 18-(600)1468] Unclassified

Presented at meeting of the AIME., Cleveland, Ohio, Oct. 29, 1958.

Published in Jour. Metals, v. 10: 29, Sept. 1958.

Using an acoustical method, the kinetics of reaging after reversion in a single crystal Al-20 wt pct Ag alloy were investigated. Reaging after reversion was studied at four temperatures between 50 and 150, and the results compared with the kinetics for aging after directly quenching from the solution temperature of 525°C. The method employed, which essentially enabled the measurement of the change in the dynamic Young's modulus as precipitation proceeded, showed that the kinetics on reaging after reversion are similar to that observed on aging after the direct quench, though decidedly slower. No incubation time has been detected in any of the above experiments, indicating that nuclei are present after reversion. The determination of an activation energy of approximately 8 kcal per mole and a time law for growth have given information concerning the growth mechanism. The exponent of time in the rate equation for growth of the zones on directly aging after quenching from 525°C is $1/2$ and 1 on reaging after reversion. The rate of formation of the zones is anomalously large indicating that, as in aging after the direct quench, there is a defect mechanism available for reaging after reversion which permits the rapid movement of silver atoms to the zones. A supersaturation of vacancies or edge dislocations acting as pipelines or a combination of these two defects may be of significance for the growth of the zones.

NOR.03:013

Northwestern U. Dept. of Metallurgy, Evanston, Ill.

SILIP IN ALUMINUM-SILVER SINGLE CRYSTALS (Abstract), by A. Kelly, A. Lassila, and S. Sato. [1958] [1]p. (AF 18(600)1468) Unclassified

Presented at meeting of the Amer. Inst. Mining, Metallurg., and Petro. Engineers, Cleveland, Ohio, Oct. 28, 1958.

NOR.10:001; NOT.02:001, 002

Published in Jour. Metals, v. 10: 25, Sept. 1958.

Stress-strain curves have been obtained of single crystals of Al-20 atomic % Ag aged varying amounts in the cold-hardening state. The temperature dependence of the flow stress of these crystals has also been measured and compared with that of pure aluminum. A striking difference is found, the flow stress of the alloy crystals depending no more on temperature than do the elastic constants over the temperature range 77°K to 373°K. The slip lines observed on the surface of the alloy crystals are similar to those found in body centered cubic metals, and it is concluded that the dislocations in this alloy behave as if they are undissociated. This behavior may be accounted for by the large stresses needed to produce slip in the alloy if the stacking fault energy is about the same as in pure aluminum.

NOR.10:001

Northwestern U. [Dept. of Metallurgy] Evanston, Ill.

STRESS INDUCED STRAIN AGING, by J. O. Brittain and S. E. Bronisz. June 6, 1958 [19]p. incl. diagrs. table, refs. (AFOSR-TN-58-369) (AF 18(600)1598) AD 154275; PB 135370

Unclassified

Also published in Trans. Metall. Soc. AIME, v. 218: 289-294, Apr. 1960.

Experiments have been carried out to study the effect of an applied stress on the strain aging phenomena in steel. It has been found that stress-induced strain aging reaction proceeds rapidly in the temperature range of 0° to 60°C. The variations of stress-induced strain aging with plastic strain, aging times, and temperatures are reported, and the activation energy for the aging found to be 10,000 cal/mol. The results are interpreted as dislocation pipe line diffusion of carbon. (Contractor's abstract)

NOT.02:001

Notre Dame U. Dept. of Chemical Engineering, South Bend, Ind.

SINTERING REACTIONS OF ZINC OXIDE, by V. J. Lee and G. Parravano. Dec. 1958, 22p. incl. illus.

diagrs. tables. (AFOSR-TN-58-811) (AF 49(638)103) AD 202356; PB 137837

Unclassified

Also published in Jour. Appl. Phys., v. 30: 1735-1740, Nov. 1959.

The sintering of zinc oxide spheres has been studied in the temperature range of from 700° to 900°C in air, oxygen, helium, and hydrogen. Fresh zinc oxide sinters rapidly in air and oxygen, but it does not sinter appreciably in helium in the same temperature range. Zinc oxide spheres annealed separately in air may be sintered in air at temperatures > 1000°C. However, air-treated spheres, which had been subsequently hydrogen-annealed, do sinter in the temperature range of from 700° to 900°C. These facts are explained on the basis of a mechanism involving the diffusional transfer of stoichiometric excess of zinc ions. The diffusion equation for zinc ions is derived, and the experimental points fit the equation satisfactorily. The treatment shows that the relationship between the width of bridges connecting sintering spheres and time varies with extent of sintering. This fact invalidates the use of this relationship as an unequivocal diagnostic criterion for the sintering mechanism in nonstoichiometric oxides. (Contractor's abstract)

NOT.02:002

Notre Dame U. Dept. of Chemical Engineering, South Bend, Ind.

SINTERING OF METAL OXIDES, by G. Parravano, Final project rept. Jan. 1, 1957-Aug. 31, 1958, 4p. (AFOSR-TR-58-166) (AF 49(638)103) AD 207974; PB 138735

Unclassified

A study was made of the sintering of metal oxides under different conditions of temperature, sphere diameter, gas atmosphere, and heat pretreatment. Single-crystal oxide microspheres (0.1 to 0.5 mm in diameter) were obtained commercially or made from crushed single crystals of ZnO, V_2O_5 , and TiO_2 . A string of spheres of similar diameter was heated for different time intervals at constant temperature, and the growth of necks or bridges connecting them was observed with a creep-test microscope. The diffusional sintering mechanism explains the experimental data for the 3 oxides and shows that their nonstoichiometric nature is decisive in controlling transport processes within their bulk phases.



ODI.01:002, 003; ODL 03:001; OSU.10:001

ODI.01:002

Odin Associates, Pasadena, Calif.

HYPERSONIC FLIGHT WITHOUT OVERHEATING. I. FRICTION HEAT ABSORPTION AND THRUST GAIN BY USE OF COOLANT-FUELS, by L. Greiner, I. Michelson, and J. Rabinowicz. June 1957, 1v. incl. diagrs. tables, refs. (Technical note no. 100-2) (AFOSR-TN-57-374) (AF 18(600)1501) AD 132448

Unclassified

The feasibility of sustained hypersonic flight within the earth's atmosphere is examined, utilizing the "coolant-fuel" system as an Aero-Thermodynamic Propulsion (ATP) Method to eliminate excessive aerodynamic frictional heating and to increase propulsive efficiency. Such systems are of current interest for all flight plans in which high speed is the prime requirement, and also for some classes of flight of prescribed range which are handicapped by insufficient unit energy content of conventional fuels (this includes, as a particular case, the problem of extreme long range manned flight). Coolant-fuels are considered from the dual standpoint of the propellant and of the missile aerodynamics. The propellant study contemplates the ability of fuels to absorb heat and the impulse gains achieved thereby. The missile study outlines a method for estimation of aerodynamic friction heating and the extent of heat transfer to the coolant-fuel as functions of the missile speed, configuration, flight plan, and state of the boundary layer. It is found that cooling which reduces equilibrium temperatures to within manageable limits can also be made to increase the energy content of suitably selected coolant-fuels by as much as 50 per cent, leading to most substantial incidental benefits to the propulsive system.

ODI.01:003

Odin Associates, State College, Pa.

PERFORMANCE ESTIMATION OF THE COOLANT-FUEL SYSTEM, by L. Greiner, J. Rabinowicz, and A. Zuckerman. Final summary rept. Dec. 1957, 35p. incl. diagrs. tables, refs. (Technical rept. no. 100-1) (AFOSR-TR-58-43) (AF 18(600)1501) AD 154150

Unclassified

This report summarizes a preliminary investigation of a novel method for preventing overheating of the external structure of a rocket powered aircraft or missile that is traveling at hypersonic speeds within the atmosphere. This method contemplates using the rocket fuel for cooling the structure. In addition to maintaining the structure at manageable temperatures, it also results in a significant augmentation of the thrust of the rocket engine because the propellant energy is enhanced by the absorbed (aerodynamic) heat. It is found that by judicious selection of fuels heat absorption of 1200 to 4000 Btu/lb can be achieved with temperature rise from 77°F to 1500°F, with corresponding augmented specific

impulse of 300 to 400 sec. A preliminary evaluation of the flight performance of this system is carried out. A method for determining the flight envelope for a missile configuration is presented. Cruise range calculations indicate that ranges of a few thousand miles are feasible. It is thus concluded that based on the promising preliminary results the coolant-fuel system merits more detailed studies. (Contractor's abstract)

ODI.03:001

Odin Associates, State College, Pa.

STUDIES IN MAGNETO-AERODYNAMICS. I. ONE-DIMENSIONAL FLOWS. II. STABILITY OF LAMINAR BOUNDARY LAYER, by H. Li, I. Michelson, and J. Rabinowicz. Dec. 1957, 43p. incl. diagrs. tables. (Technical rept. no. 102-1) (AFOSR-TR-58-28) (AF 42(638)-13) AD 152206; PB 135414

Unclassified

The governing equations of magneto-aerodynamics are examined for the weak interaction approximation. It is found that for the case where $R_v R_H \ll 1$ it is possible to treat the magneto-aerodynamic interaction as a simple additional body force. Accordingly, the approximate equations for weak interaction are derived. These are applied to several simple one-dimensional flows such as the propagation of small disturbances and one-dimensional flows such as the propagation of small disturbances and one-dimensional channel flow. The stability of incompressible laminar boundary layer on a flat plate with the presence of a transverse magnetic field fixed with respect to the plate is considered in Part II. It is found that for this case the effect of the magnetic field is to de-stabilize the boundary layer, caused mainly due to the modification of the mean velocity profile by the magnetic field. (Contractor's abstract)

OSU.10:001

Ohio State U. Research Foundation, Columbus.

PRODUCTION OF CLINICAL ROENTGENOGRAMS BY MEANS OF COMPACT RADIOACTIVE X-RAY AND GAMMA-RAY SOURCES, by H. D. Spangenberg, Jr. and M. L. Pool. Final rept Oct. 1957, 31p. incl. illus. diagrs. tables, refs. (AFOSR-TR-57-95) (AF 18(600)1305) AD 136752

Unclassified

New and known radioactive isotopes have been synthesized and investigated which emit x-rays and/or low energy gamma-rays suitable for roentgenographic visualization of the teeth and their supporting structures. Data on the following isotopes were collected: Ce 144, Eu 155, Sm 145, La 137, Dy 157, Dy 159, Yb 169, Gd 161 and Tb 157. The difficulties encountered in the preparation of any one of the above radioactive substances, in sufficiently pure form, make it impossible to designate any single activity as the ideal source for all types of

OSU.11:001, 002; OSU.03:020-022

low energy radiography. Ce 144 and Sm 145 have acceptable characteristics and their use has resulted in good quality radiographs. (Contractor's abstract)

OSU.11:001

Ohio State U. Research Foundation, Columbus.

PROCEEDINGS OF THE SYMPOSIUM ON SOLID AND

LIQUID He³, Ohio State U., Columbus (Aug. 20-23, 1957), ed. by J. G. Daunt. Aug. 1957, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TR-57-78) (AF 49(638)-225; continuation of AF 18(600)1003) AD 232154
Unclassified

This volume contains the papers presented at the symposium and a resumé of the discussions that followed. General topics dealt with at the sessions are: (1) experimental results on pure liquid He³; (2) the theory of liquid He³, including model theories, the relationship of properties of liquid He³ and He⁴, and approaches from first principles; (3) solid He³; (4) experimental results on solutions of He³ in He⁴; and (5) theories of mixtures of isotopes.

OSU.11:002

Ohio State U. Research Foundation, Columbus.

SYMPOSIUM ON LIQUID AND SOLID He³: SUPPLEMENT. Aug. 1957, 1v. incl. diagrs. refs. (AFOSR-TR-57-78a) [AF 49(638)225] AD 245140
Unclassified

This volume includes papers given at the symposium which arrived too late to be compiled with the original Proceedings. The subjects dealt with are (1) nuclear susceptibility of liquid He³, (2) nuclear spin ordering in solid He³, and (3) nuclear resonance experiments in He³-He⁴ solutions.

OSU.03:020

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

A CLEAVAGE REACTION INVOLVING α -METHYL-STYRENE OXIDE, by J. Hoffman. [1957] [2]p. (AFOSR-TN-57-252) (AF 18(600)787) AD 126550
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 503-504, Jan. 20, 1957.

It has been found that α -methylstyrene oxide (1,2-epoxy-

1-methylethylbenzene) when allowed to react with alkaline hydrogen peroxide in 90% methanol at room temperature gives an almost quantitative yield of acetophenone.

OSU.03:021

[Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.]

ABSORPTION CHROMATOGRAPHY IN THE ANALYSIS OF COOL-FLAME COMBUSTION PRODUCTS, by G. Kyriacos and C. E. Boord. [1957] [9]p. incl. diagrs. (AFOSR-TN-57-253) [AF 18(600)787] AD 126551
Unclassified

Presented at meeting of the Analyt. Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Abstract published in 131st meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 35-B-36-B.

Oberdorfer in cool-flame combustion studies of the isomeric hexanes determined residual paraffins, residual oxygen H₂, CO, CO₂ and olefins by the usual methods of gas analysis. Water was undetermined. Gas absorption chromatography now has been applied to this purpose. Water, previously estimated on the basis of an oxygen balance, is now determined by measuring the acetylene produced by passing the product mixture over a CaC capsule before entering the silica gel column. In gas chromatography best results are obtained on columns the length of which is not more than eight feet. In the analysis of combustion products chromatographic columns must be developed to analyze for compounds containing specific function groups. Occasionally columns will be found which will separate such groups completely. The Dowtherm-A column is an example of this type. For best results it is found that flow-rates and column temperature should be kept as low as possible but not so low that the products fail to come off the column in less than 45 minutes. The ability to separate the oxygen and nitrogen of the air completely and cleanly is very useful in the combustion analysis of hydrocarbons. It has been shown that almost any hydrocarbon having a research octane number below 90 will form a cool-flame and give a typical temperature profile. It is indicated that under suitable conditions the three n-paraffins all burn at the same rate. (Contractor's abstract)

OSU.03:022

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

A DETAILED REACTION MECHANISM FOR THE COOL-FLAME COMBUSTION OF N-HEXANE, by C. E. Boord. [1957] 17p. incl. tables, refs. (AFOSR-TN-57-254) (AF 18(600)787) AD 126552
Unclassified

OSU.03:023; OSU.12:001-003

Presented at meeting of the Petrol. Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Abstract published in 131st meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 12-Q.

This paper is a summary and extension of previously published work on cool flames (see item nos. OSU.03:010 and OSU.03:015). A completely detailed reaction mechanism is presented to account for the 14 known and measured cool-flame combustion products of n-hexane. Any reaction mechanism which will in a logical, straightforward manner account for this number of intermediate products seems almost self-sustaining. The reaction mechanism not only fits the facts but contains a certain degree of flexibility permitting the known variations, with changes in experimental conditions.

OSU.03:023

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

MECHANISM OF THE OXIDATION OF HYDROCARBONS, by C. E. Boord. Final rept. Sept. 15, 1955-Apr. 15, 1958, 116p. incl. diagrs. tables, refs. (AFOSR-TR-58-82) (AF 18(600)787) AD 158384 Unclassified

The technical summaries presented describe the results obtained in the various areas of investigation in the mechanism of oxidation hydrocarbons. The subjects include: Kinetics of the Reaction of Oxygen with Liquid Cyclohexene; Gas Phase Oxidation of Cyclohexene; Liquid Phase Oxidation of Cyclohexene in Teflon Containers; Kinetics of the Low-Temperature Gas Phase Oxidation of n-Pentane in a Static System; Liquid Phase Oxidations; Alkyl Hydroperoxides in Vapor Phase Oxidation of Hydrocarbons; Flash Thermal Decomposition of Peroxides; The Chemical Shock Tube in Oxidation of Hydrocarbons; Study of Preflame Reactions in a Motored Engine; Chemical Reactions in the Preflame Phenomenon; Organic Hydroperoxides from Dienes and Diols; Gas Chromatography and Cool-Flame Studies; Study of the Gas Phase Oxidation of Hydrocarbons; Polarographic Analysis and Research; Infrared Analysis and Research; and A Detailed Reaction Mechanism for the Cool-Flame Combustion of n-Hexane. (Contractor's abstract)

OSU.12:001

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

RARE EARTH OXIDES. I. THE VAPORIZATION OF NEODYMIUM SESQUIOXIDE, Nd_2O_3 . DISSOCIATION ENERGY OF NdO AND TaO , by H. [W.] Goldstein, P. N. Walsh, and D. White. Jan. 1958, 16p. incl. tables, refs. (Technical note no. 1) (AFOSR-TN-58-291) (AF 18(600)1545) AD 154196 Unclassified

The vaporization of Nd_2O_3 has been studied by the

Knudsen effusion method in the temperature range 2040 to 2450°K. Both tungsten and tantalum effusion cells were used in the experiments. From the tungsten refractory, the vaporization of Nd_2O_3 proceeds predominately

by dissociation to gaseous products, NdO and O , whereas in the case of the tantalum refractory, the Nd_2O_3 reacts with the cell and yields primarily the gaseous species NdO and TaO . From the vapor pressure determinations, with the aid of free energy functions, the heat of reactions were established. The dissociation energies of TaO and NdO were calculated, and the value for TaO was found not to be in agreement with the recent value reported from mass spectrometric studies. Some reasons for this apparent discrepancy are given. (Contractor's abstract, modified)

OSU.12:002

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

RARE EARTH OXIDES. II. THE VAPORIZATION OF LANTHANUM SESQUIOXIDE, La_2O_3 , AND YTTRIUM SESQUIOXIDE, Y_2O_3 ; DISSOCIATION ENERGIES OF LaO , YO , AND TaO , by P. N. Walsh and D. White. Feb. 1958, 19p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-58-382) (AF 18(600)1545) AD 154289 Unclassified

The vaporization of La_2O_3 and Y_2O_3 from tungsten and tantalum refractories has been studied by the Knudsen effusion method in the temperature ranges 2000-2450°K and 2000-2700°K, respectively. The sesquioxides decompose to the corresponding monoxides and oxygen on vaporization from tungsten cells, while gaseous LaO and TaO are the principal products formed in the vaporization of La_2O_3 from a tantalum effusion cell. The Y_2O_3 also reacts with tantalum, yielding a mixture of gaseous YO , Y , and TaO . A method is described for deriving equilibrium concentrations and heats of formation from Knudsen effusion data when more than one reaction occurs in the Knudsen cell. (Contractor's abstract, modified)

OSU.12:003

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

RARE EARTH OXIDES. III. THE HEAT CAPACITIES OF YTTRIUM OXIDE (Y_2O_3), LANTHANUM OXIDE (La_2O_3) AND NEODYMIUM OXIDE (Nd_2O_3) FROM 16 TO 300°K, by H. W. Goldstein, E. F. Neilson and others. Oct. 1958, 18p. incl. diagrs. tables, refs. (Technical rept. no. 3) (AFOSR-TN-58-1093) (AF 18(600)1545) AD 207596 Unclassified

OSU.06:005, 006; OSU.07:004, 005

Also published in Jour. Phys. Chem., v. 63: 1445-1449, Sept. 1959.

The heat capacities of the sesquioxides of yttrium, lanthanum, and neodymium have been determined in the temperature range 16 to 300°K. The entropies, enthalpies, and free energy functions have been calculated from the heat capacity data and are tabulated for several temperatures. Yttrium oxide and lanthanum oxide exhibit typical sigmoidal heat capacity curves with no anomalies in the temperature range studied. The shape of the heat capacity curve for neodymium oxide is similar except that at the lowest temperature there is evidence for the existence of an anomaly. At 298.16°K the entropies are 23.693 ± 0.07 and 30.580 ± 0.07 cal $\text{mol}^{-1} \text{deg}^{-1}$ for yttrium oxide and lanthanum oxide, respectively. For neodymium oxide $S_{298.16}^{\circ} = 33.607$ cal $\text{mol}^{-1} \text{deg}^{-1}$. The free-energy functions have been extended to 2500°K by the use of some higher temperature heat capacity data available in the literature. (Contractor's abstract)

OSU.06:005

Ohio State U. Research Foundation. Dept. of Electrical Engineering, Columbus.

A HIGH-PERVEANCE ELECTRON GUN ON TOROIDAL DESIGN, by W. E. Hoovler. May 1957, 24p. incl. diagrs. table. (Technical note no. 5) (AFOSR-TN-57-334) (AF 18(600)980) AD 132408 Unclassified

The report describes modifications of a high-perveance electron gun designed by A. L. Samuel at Bell Telephone Labs. in 1944. Modifications were made to facilitate construction and to afford more versatile operation of the gun. The perveance of the gun is variable from a maximum of about 45×10^{-6} amp/volt^{3/2} to a minimum which is determined by the cathode-anode spacing. The cathode of the gun is a 120° section of a toroid with a maximum cathode diameter of 0.366 in. The gun's distinguishing characteristic is the presence of a focusing anode immersed in the cathode region. By variation of the position voltage on this electrode, transmission of current through a conventional anode can be maximized, or, if desirable, judicious adjustment of this voltage can be used to shape the electron beam. Beam profiles obtainable with this gun range from a thin, ring-shaped beam to a solid beam. (Contractor's abstract)

OSU.06:006

Ohio State U. Research Foundation. Dept. of Electrical Engineering, Columbus.

A STUDY OF SPACE-CHARGE-LIMITED POTENTIAL DISTRIBUTION IN ELLIPSOIDAL AND PARABOLOIDAL DIODES, by R. P. Anand. June 1958, 121p. incl. illus.

diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-58-570) (AF 18(600)980) AD 158389 Unclassified

Space-charge-limited potential distributions in certain new geometries were investigated with a view to developing better high-density electron beams. The problems studied include confocal and nonfocal ellipsoidal and paraboloidal geometries. A cathode and anode were chosen as confocal ellipsoids with axial ratios of 1.3 and 10, respectively. This particular choice was guided by its closeness to the Heil ellipsoidal gun. Results of the study showed that (1) the cathode current density is higher (about 100%) than the corresponding ellipsoidal gun; (2) the electron flow is laminar; (3) the concentration ratio is poor; and (4) the cathode current density is nonuniform. Good convergence can be achieved if a focusing electrode is added and the anode ellipsoid moved further along the axis of symmetry (which is also the minor axis of the ellipsoid). The major axes of cathode and anode are no longer coincident but are parallel. A gun with the following particulars was designed: cathode-ellipsoid with an axial ratio of 1.3; anode-ellipsoid with an axial ratio of 10; and distance between major axes of cathode and anode is equal to half the semi-minor axis of the cathode. The current density at the cathode surface is nonuniform and increasing in the ratio 1:2.

OSU.07:004

Ohio State U. Research Foundation. [Dept. of Electrical Engineering] Columbus.

MILLIMETER WAVE GENERATION AT THE OHIO STATE UNIVERSITY, by M. O. Thurston. [1957] 10p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)982 and Wright Air Development Center) Unclassified

Published in Proc. First Tri-Service Millimeter Wave Symposium, Army Signal Engineering Labs., Fort Monmouth, N. J., Sept. 10-11, 1957, p. 1-13.

Investigations have been conducted on oscillators capable of providing a moderate amount of c-w power at high frequencies. In most instances, emphasis has been placed on attaining a wide tuning range. Much of the work has been on klystrons, retarding-field oscillators, Barkhausen-Kurz oscillators and variations of each. The principles of operation, performance, and modifications necessary to make each of these tubes a more practical device are discussed.

OSU.07:005

Ohio State U. Research Foundation. Dept. of Electrical Engineering, Columbus.

STUDIES ON THE BARKHAUSEN-KURZ OSCILLATOR AT CENTIMETER AND MILLIMETER WAVELENGTHS, by F. S. Chen and D. T. Davis. Aug. 1958, 54p. incl.

OSU.13:001; OSU.14:001;
OSU.08:020, 021

diags. table. (Technical note no. 4) (AFOSR-TN-58-826) (AF 18(600)982) AD 202911 Unclassified

The present investigation discusses the effects of multiple transits on the electronic admittance of the oscillator and the corresponding effects on efficiency and electronic tuning. Limitations on the realizable number of transits are developed and correlated with experimental results. Theoretical values are also obtained for the starting currents and are in good agreement with experiment. Two basic tube types have been tested, one having symmetry about the plane of a flat electron beam, and one having symmetry about the axis of a cylindrical electron beam. The tube having planar symmetry has yielded the better results, probably due to the less severe cathode loading and space-charge effects. A maximum efficiency of 13.5% and maximum power output of 1.8 w have been obtained at 8,400 mc with the planar tube, while the maximum efficiency obtained with the axially symmetric tube was 7% at 12,500 mc. The maximum power output obtained with the latter was 400 mw at 9,100 mc. (Contractor's abstract)

OSU.13:001

Ohio State U. Research Foundation. Dept. of Electrical Engineering, Columbus.

RESEARCH ON PHYSICAL LIMITATIONS ON PRODUCTION AND USE OF RF ENERGY IN MILLIMETER WAVELENGTH RANGE, by M. O. Thurston and W. H. Cornet, Jr. Final rept. July 1958, 54p. incl. diags. tables, refs. (Rept. 719) (AFOSR-TN-58-133) (AF 49(638)53) AD 203968; PB 139464 Unclassified

The results of a survey of the literature on millimeter wavelength devices is presented. The high frequency limit for most conventional sources is in the range from 3 mm to 1 mm. Harmonic generators of several types are discussed. A detailed analysis of a velocity variation harmonic generator is followed by a preliminary analysis of frequency multipliers based on field emission and on the failure of Ohm's law in semiconductors. The feasibility of obtaining sub-millimeter waves from the radiation of electrons in a high magnetic field is also investigated. (Contractor's abstract)

OSU.14:001

Ohio State U. Research Foundation. Dept. of Mathematics, Columbus.

ON SINGULARITIES OF SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS IN THREE VARIABLES, by E. Kreyszig. Dec. 1958 [9p. incl. refs. (Technical rept. no. 1) (AFOSR-TN-58-933) (AF 49(638)362) AD 205098 Unclassified

Also published in Arch. Rational Mech. Anal., v. 2: 151-159, 1958.

Partial differential equations in three variables of the type $v_{x_1 x_1} + v_{x_2 x_2} + v_{x_3 x_3} + \sigma(x_2, x_3) v = 0$ are studied

in such a way as to show the possibility of setting them up for solution by means of using Bergman operators which can "translate" analytic functions into theorems on solutions of partial differential equations in two variables. The situation is expanded to the case where solutions are given of certain classes of more general partial differential equations in three variables with analytic coefficients by means of a further application of Bergman operators.

OSU.08:020

Ohio State U. Research Foundation. [Dept. of Physics and Astronomy] Columbus.

MULTIPOLAR STARK SPLITTING PATTERNS IN SINGLE CRYSTALS, by P. M. Parker. Dec. 6, 1956 [3p. incl. tables. [Part 3 of technical rept. no. 4] (AFOSR-TN-57-23) (AF 18(600)772) AD 115057(b) Unclassified

Also published in Phys. Rev., v. 105: 1713-1715, Mar. 15, 1957.

The theoretical relative splitting schemes of the energy levels of a nuclear nonspherical charge distribution in the electric field of the crystalline surroundings are calculated for some relevant symmetries of the electric crystalline field. The results are intended as a guide to possible experimental observation of nuclear multipole interactions of order higher than the quadrupole interaction. (Contractor's abstract)

OSU.08:021

Ohio State U. Research Foundation. [Dept. of Physics and Astronomy] Columbus.

FREQUENCY STABILIZATION OF A REFLEX KLYSTRON WITH RESPECT TO A CRYSTAL-CONTROLLED SECONDARY FREQUENCY STANDARD, by J. E. Geusic, L. D. Farringer, and L. C. Brown. [1957] [3p. incl. diagr. (AFOSR-TN-57-70) (AF 18-600)772] AD 120413 Unclassified

A klystron frequency stabilizer is described which has achieved frequency stabilization comparable to the Pound system without using a resonant cavity as a reference. The system frequency stabilizes the klystron, frequency-tunes a klystron linearly with time over a range of 10mc-sec by simply tuning the HRO-50 receiver and automatically measures and controls the actual frequency of the klystron to a high degree of accuracy.

OSU.08:022 - OSU.08:026

OSU.08:022

Ohio State U. Research Foundation. [Dept. of Physics and Astronomy] Columbus.

COMPUTATION OF RIGID ASYMMETRIC ROTATOR CONSTANTS FROM ENERGY MOMENTS, by L. C. Brown and P. M. Parker. [1957] 8p. incl. refs. (AFOSR-TN-57-545) (Also bound with its Technical rept. no. 10; AD 251670) (AF 18(600)772) Unclassified

Also published in Jour. Chem. Phys., v. 27: 1108-1113, Nov. 1957.

Expressions are developed which relate the rotational constants of the rigid asymmetric rotator to experimental data through moments of the energy levels. The procedure in many cases permits the computation of rotational constants with much less effort than is usually met in either numerical approximation to roots of secular equations or perturbation methods. (Contractor's abstract)

OSU.08:023

Ohio State U. [Research Foundation] [Dept. of Physics and Astronomy] Columbus.

NUCLEAR RESONANCE SPECTRUM OF Al^{27} IN CHRYSOBERYL, by J. H. Hockenberry, Jr., L. C. Brown, and D. Williams. [1957] 10p. incl. tables. (AFOSR-TN-57-622) (AF 18(600)772) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 225, Apr. 25, 1957.

Also published in Jour. Chem. Phys., v. 28: 367-372, Mar. 1958.

The nuclear magnetic resonance spectrum of Al^{27} in a single crystal of chrysoberyl ($BeAl_2O_4$)₄ has been investigated at room temperature in a field of 7800 gauss. The spectra obtained as the crystal was rotated about the three crystal axes have been interpreted on the basis of eight Al^{27} sites of two distinct types, the four sites of each type differing only in the orientation of the principal field gradients. Quadrupole coupling constants and electric field asymmetry parameters at the two types of sites were determined to be

	Type I site	Type II site
$C_z = eQ \cdot \frac{1}{2} h$	$2830 \pm 15 \text{ kc/sec}$	$2846 \pm 15 \text{ kc/sec}$
$\eta = \frac{(C_{zz} - C_{yy})/C_{zz}}{C_{zz}}$	0.94 ± 0.02	0.76 ± 0.02

In addition, the orientation of the principal field gradients has been determined at each of the eight sites. (Contractor's abstract)

OSU.08:024

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

GROUP THEORY OF THE SPIN-HAMILTONIAN, by J. Korringa. Aug. 1957, 70p. incl. tables, refs. (Technical note no. 5) (AFCSR-TN-57-780) (AF 18(600)772) AD 148012 Unclassified

An investigation is made to determine the possibilities of combining quantum mechanical perturbation theory and group theoretical arguments in order to develop an analytical formalism for dealing with the symmetry properties of crystals through the so called spin-Hamiltonian theory. Special attention is given to the group-theoretical problems of the spin-Hamiltonian theory. The general principles which underlie the construction of invariant operators and the exclusion of non-physical operators are discussed. A generalization of Kramer's method for discussing the multiplet splitting in free atoms or ions is developed. The entire investigation is limited to situations in which an unperturbed system can be found for which the one-level spin-Hamiltonian is satisfactory.

OSU.08:025

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

VALIDITY OF A PERTURBATION TREATMENT OF THE QUADRUPOLE ENERGY LEVELS OF SODIUM CHLORATE (Abstract), by P. M. Parker. [1957] [1]p. (AF 18(600)772) Unclassified

Presented at meeting of the Amer. Phys. Soc., Boulder, Colo., Sept. 5-7, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 329, Sept. 5, 1957.

A fifth order perturbation treatment of the Cl^{35} quadrupole energy levels of sodium chlorate has been re-examined in the light of a more recent numerical treatment of quadrupole energy levels in single crystals. This examination ascertained that the fifth order perturbation treatment is substantially valid, even though poor convergence is involved in some of the perturbation coefficients. From this it is concluded that the coupling constants quoted for sodium chlorate are correct, but that the limits of error quoted for the effective nuclear magnetic dipole moment should more appropriately be ± 0.002 nuclear magnetons.

OSU.08:026

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

INTERACTIONS BETWEEN ELECTROMAGNETIC

OSU.08:027 - OSU.08:030

RADIATION AND MATTER, by D. Williams. Quarterly rept. Dec. 1, 1957-Feb. 28, 1958. Mar. 22, 1958, 8p. incl. refs. (Rept. no. 583-19) (AFOSR-TN-58-300) (AF 18(600)772) Unclassified

A brief resumé is given of the research on: (1) paramagnetic resonance, (2) nuclear quadrupole transitions, (3) nuclear magnetic resonance, and theoretical studies on the spin Hamiltonian and rigid asymmetric rotator, which was carried out under this contract from Dec. 1957 to Mar. 1958.

OSU.08:027

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

ENERGY MOMENT TREATMENT OF THE QUANTUM MECHANICAL ASYMMETRIC ROTATOR, by P. M. Parker and L. C. Brown. Mar. 1958, 103p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-58-371) (AF 18(600)772) AD 154277 Unclassified

A method has been presented which relates the physical parameters associated with the description of a quantum mechanical system to the energy eigenvalues of the Schrödinger equation of the system. For relatively simple systems the physical parameters can be evaluated from spectroscopic data without effecting a detailed solution for the roots of secular polynomials. Application of the method to a system described by a rigid asymmetric rotator Hamiltonian has resulted in relatively simple closed expressions for effective rotational constants in terms of experimentally determined quantities. Use of the rigid asymmetric rotator expressions has been illustrated for the water molecule. The theory has been extended to include explicitly first order stretching effects for an asymmetric top model. Centrifugal stretching effects in the water molecule are discussed in terms of the first order theory.

OSU.08:028

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

ZEEMAN SPLITTING OF NUCLEAR QUADRUPOLE LEVELS IN CUPRITE, by H. L. Cox, Jr. and D. Williams. [1958] 11p. incl. table, refs. (AFOSR-TN-58-453) (AF 18(600)772) AD 158259 Unclassified

Also published in Jour. Chem. Phys., v. 32: 633-634, Feb. 1960.

The radio-frequency spectrum of a single cuprite (Cu_2O) crystal in an external magnetic field has been investigated. The electric quadrupole transition lines in the vicinity of 26 mc/sec for Cu^{63} and 24 mc/sec

for Cu^{65} are split by the magnetic field. From the resulting pattern, it can be shown that the electric asymmetry parameter is $\eta < 0.0012$. The analysis of the spectra obtained for various orientations of the crystal in the magnetic field leads to the following values for the pertinent parameters:

$$(eQq)^{83} = 51.958 \pm 0.04 \text{ mc/sec (at } 28^\circ \text{ C)}$$

$$(eQq)^{85} = 48.085 \pm 0.04 \text{ mc/sec (at } 28^\circ \text{ C)}$$

$$\mu^{83} = 2.2281 \pm 0.007 \text{ n.m.}$$

$$\mu^{85} = 2.3785 \pm 0.007 \text{ n.m.}$$

$$Q^{83}/Q^{85} = 1.0808 \pm 0.009$$

$$\mu^{85}/\mu^{83} = 1.0878 \pm 0.006$$

Within the indicated limits, these values are in agreement with values of eQq obtained for powdered samples of cuprous oxide with values for μ obtained with liquid samples. The temperature dependence of eQq has also been determined; the eQq variation with temperature is the same for Cu^{83} and for Cu^{65} within the limits of the present measurements. (Contractor's abstract)

OSU.08:029

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

COMPUTATION OF THE PRINCIPAL COMPONENTS OF AN ASYMMETRIC g TENSOR FROM PARAMAGNETIC RESONANCE DATA, by J. E. Geusic and L. C. Brown. [1958] 6p. (AFOSR-TN-58-508) (AF 18(600)772) AD 158319 Unclassified

Also published in Phys. Rev., v. 112: 64-65, Oct. 1, 1958.

A straightforward method is developed for obtaining the principal components of the asymmetric tensor g and its orientation in a crystal system. The necessary paramagnetic resonance data involves three crystal rotations about arbitrary orthogonal axes. Although the spin Hamiltonian is probably not applicable except for $S = \frac{1}{2}$, the development, which is based upon a calculation of the second moment of the energy levels about their mean, is quite general. (Contractor's abstract)

OSU.08:030

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

PARAMAGNETIC RESONANCE STUDY OF IRRADIATION DAMAGE IN CRYSTALLINE CARBOHYDRATES, by D. Williams, J. E. Geusic and others. [1958] 9p. incl. diagrs. refs. (Technical note no. 7) (AFOSR-TN-58-840) (AF 18(600)772) AD 203082 Unclassified

OSU.08:031 - OSU.08:034

Also published in Proc. Nat'l. Acad. Sciences, v. 44: 1128-1136, Nov. 1958.

In most of the irradiated carbohydrates studied, the existence of hyperfine structure in the paramagnetic resonance spectrum suggests the general nature of the radical produced by the radiation. From a consideration of the chemical structure of some of these sugars, some of the similarities observed in the spectra of different sugars were not surprising. The structures are given for α -D-glucopyranose monohydrate and α -D-galactopyranose. The only difference in structure of these two sugars is the relative configuration about C4. Since there is such a great similarity in the structure of these two sugars, the radicals produced by irradiation of these molecules would give similar paramagnetic resonance spectra. The spectra of the two ketohexoses, β -D-fructopyranose and L-sorbose (detailed structure unknown), are similar. The spectra of erythritol and D-threitol were found to be similar, and again the only difference in structure of these two is the relative position of a hydroxyl group. It is hoped that the results of the paramagnetic resonance studies which have been carried out can be used in helping to decide what radicals are formed by the ionizing irradiation.

OSU.08:031

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

THE RESONANCE SPECTRUM OF A PARAMAGNETIC IMPURITY IN TOPAZ (Abstract), by J. E. Geusic and D. Williams. [1958] 1p. (AFOSR-TN-58-1126) (AF 18-(600)772) AD 207835 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 260, Apr. 30, 1959.

The paramagnetic resonance spectrum of a single crystal of topaz $(\text{AlF})_2\text{SiO}_4$ containing Fe and Cr as impurities has been investigated at X-band. At present the paramagnetic resonance spectra observed cannot be ascribed to either Cr or Fe ions in the lattice. However, from the symmetry properties of the resonance spectra observed as the crystal is rotated with respect to the magnetic field and from hyperfine structure which is present, the paramagnetic center is identified as occupying Al sites in the topaz lattice.

OSU.08:032

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

COMPUTATION OF ASYMMETRIC ROTATOR CONSTANTS FROM ENERGY MOMENTS (Abstract), by

P. M. Parker and L. C. Brown. [1958] [1]p. (AF 18-(600)772) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 53, Jan. 29, 1958.

A procedure has been described previously which relates the rotational constants of the rigid asymmetric rotator to experimental data through moments of the energy levels. This procedure in many cases permits the computation of rotational constants with much less effort than is usually met in either numerical approximation to roots of secular equations or perturbation methods. Moments have been calculated based on a more general asymmetric rotator Hamiltonian which includes terms allowing for first order stretching effects. Also, for the rigid rotator Hamiltonian calculations have been made which are based on the factored form of the secular determinants. The results were presented and discussed.

OSU.08:033

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

COMPUTATION OF THE PRINCIPAL COMPONENTS OF AN ASYMMETRIC (g) TENSOR FROM PARAMAGNETIC RESONANCE DATA (Abstract), by J. E. Geusic and L. C. Brown. [1958] [1]p. (AF 18(600)772) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 8, Jan. 29, 1958.

In the case of a paramagnetic crystal in which the effective Hamiltonian of the paramagnetic ion is

$$H = \sum_{ij} \beta g_{ij} H_i S_j$$

a method will be outlined by which one can obtain in a simple and direct manner the components of the $(g_{ij})^2$ tensor from rotation data about any three mutually orthogonal axes whose relation to the crystal axes is known. Finally from the components of the $(g_{ij})^2$ tensor the principal g components and the orientation of the principal coordinate system of this g tensor relative to the arbitrary orthogonal system are found.

OSU.08:034

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

NUCLEAR MAGNETIC RESONANCE SPECTRA OF ALKALI HALIDE SOLUTIONS (Abstract), by D. D.

OSU.08:035; OSU.09:005, 006

Elleman, L. C. Brown, and D. Williams. [1958] [1]p. (AF 18(600)772) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 166, May 1, 1958.

Resonances for Li^7 , Na^{23} , Rb^{85} , Rb^{87} , Cs^{133} , Cl^{35} , Br^{79} , Br^{81} , and I^{127} have been studied in aqueous solutions of alkali halides. Line widths and frequency shifts were measured as functions of concentration. The widths of the broader lines have been interpreted qualitatively in terms of nuclear quadrupole effects. The widths of certain resonance lines in D_2O solutions are not noticeably different from those in H_2O solutions.

Addition of ethanol is found to increase the widths of some lines. The ratio of the line widths of Br^{79} to Br^{81} extrapolated to zero concentration is proportional to the square of the ratio of the nuclear quadrupole moments, an observation in agreement with Pound's results for a single dilute solution. The shift in frequency with concentration is interpreted qualitatively in terms of the ionic environment.

OSU.08:035

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

PARAMAGNETIC RESONANCE SPECTRUM OF Fe^{+++} IN BLUE SAPPHIRE AT 300°K (Abstract), by J. K. Geusic and D. Williams. [1958] [1]p. (AF 18(600)772) Unclassified

Presented at annual Conf. of the Cleveland, Ohio, Soc. of Spectroscopy, May 21, 1958.

Paramagnetic resonance of Fe^{+++} in $\alpha\text{-Al}_2\text{O}_3$ has been observed at 300°K by means of a spectrograph operating at 9000 mc/sec. Four resonance lines are observed when the trigonal axis of the crystal is parallel to the external magnetic field. The lines have been tentatively assigned to transitions based on a spin Hamiltonian of the form:

$$H_s = g\beta H \cdot S + D \cdot 3S_z^2 - S(S+1) + F \cdot 35S_z^4 - 30S(S+1)S_z^2 + 25S_z^2 - 6S(S+1) + 3S^2$$

$$(S_x^2 + S_y^2) + \frac{G}{2} [(S_x^3 + S_y^3) + (S_x^3 - S_y^3)S_z] + i[S_z(S_x^3 - S_y^3) + (S_x^3 - S_y^3)S_z]$$

The parameters

obtained from the experimental data are:

$$g = 2.003 \pm 0.008$$

$$D = 7.67 \pm 0.02 \times 10^{-2} \text{ cm}^{-1}$$

$$F = 2.31 \pm 0.03 \times 10^{-4} \text{ cm}^{-1}$$

$$|G| = 1.93 \pm 0.4 \times 10^{-3} \text{ cm}^{-1}$$

Certain discrepancies between the observed spectrum and the predicted spectrum will be discussed.

OSU.09:005

Ohio State U. Research Foundation. [Dept. of Physics and Astronomy] Columbus.

F-CENTERS IN X-RAY IRRADIATED KCl , NaCl , AND NEUTRON IRRADIATED LiF (Abstract), by F. J. Reid, R. T. Bate, and C. V. Heer. [1957] [1]p. (AF 18(600)-1003) Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 154, Mar. 21, 1957.

The number of magnetic centers in x-ray irradiated KCl , NaCl and neutron irradiated LiF were determined by measuring the static magnetic susceptibility down to liquid helium temperatures with a sensitive torsion balance. Optical absorption measurements were made at room temperature. Under the assumption that the temperature dependent paramagnetic susceptibility is due primarily to the F-centers, optical oscillator strengths for KCl and NaCl were in agreement with previous results on additively colored crystals. LiF crystals were irradiated with varying neutron fluxes, and the concentrations of magnetic centers exceeded $10^{20}/\text{cc}$ in the intensely colored crystals. Concentration as a function of neutron flux is discussed.

OSU.09:006

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

SOME OPTICAL AND MAGNETIC PROPERTIES OF IRRADIATED LiF , by R. T. Bate and C. V. Heer. Jan. 1958, 18p. incl. diagrs. tables, refs. (AFOSR-TN-58-125) (AF 18(600)1003) AD 152152 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 7: 14-21, Oct. 1958.

The optical oscillator strength of the F-band in LiF is determined as $f_L = 0.82$ from combined optical and magnetic measurements on x-irradiated and neutron irradiated samples. The number of F-centers formed in LiF

OSU.09:007; OSU.15:001, 002;
OSU.16:001

as a function of neutron dosage was measured over a broad range of dosage by either optical or magnetic techniques. The formation of F-centers saturates in the vicinity of 8×10^{19} centers/cm³; and saturation occurs for neutron dosages considerably smaller than required for saturation of vacancies and interstitials. Experimental evidence is presented to indicate that F-centers are separated by more than 6 lattice units in the most densely colored samples. (Contractor's abstract)

OSU.09:007

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

INVESTIGATION OF THE EFFECTS OF DEFECTS PRODUCED IN SOLIDS BY IRRADIATION OR OTHERWISE, by C. V. Heer. Final technical rept. Oct. 15, 1954-Dec. 14, 1957. Jan. 1958, 8p. incl. refs. (AFOSR-TR-58-59) (AF 18(600)1003; continued by AF 49(638)-225) AD 154297 Unclassified

A partial description of the activities of the various participants and their contributions to the research program are given with references to publications, papers, and theses. Then, a more detailed discussion is presented of some of the activities. These activities include (1) the correlation of the magnetic and optical properties of F-centers; (2) the correlation of the optical and magnetic properties of x-irradiated KCl and NaCl and of thermal neutron-irradiated KI and KBr; (3) a study of the change in paramagnetism as the F-M band conversion occurs under irradiation in the F-band; (4) a study of the optical and magnetic properties of x-irradiated and thermal neutron-irradiated LiF; and (5) an examination of the magnetic and optical properties of V-centers formed in KI upon coloration with iodine vapor at pressures of the order of 25 atm.

OSU.15:001

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

COBALT METAL AS A LOW-TEMPERATURE HEAT RESERVOIR, by C. V. Heer and R. A. Erickson. [1958] [1]p. incl. table. (AF 49(638)254) Unclassified

Published in Rev. Scient. Instruments, v. 29: 440, May 1958.

Data suggest that metallic cobalt, or other metals with similar hyperfine coupling, are very promising as large heat capacity-high thermal conductivity heat reservoirs at temperatures below 1°K.

OSU.15:002

Ohio State U. Research Foundation. [Dept. of Physics and Astronomy] Columbus.

HYPERFINE COUPLING IN METALS (Abstract), by C. V. Heer. [1958] [1]p. [AF 49(638)254] Unclassified

Presented at Kamerlingh Onnes Conf. on Low Temperature Physics, Leyden (Netherlands), June 23-28, 1958.

Published in Physica, v. 24: S155, Sept. 1958.

The evaluation of the anomalous specific heat in transition metals below 1°K which is attributed to the hyperfine coupling between the nucleus and the electronic magnetic moment of the atom is of considerable importance in the study of the orientation of nuclei in ferromagnetic materials, in the study of the electronic wave functions in metals, and in low temperature research. The measurement of the specific heat of metallic cobalt has been extended to lower temperatures on the same cobalt specimen and with the same magnetic refrigerator-calorimeter which was used by Heer and Erickson. Data in agreement with that previously reported is obtained. The anomalous specific heat or that part of the specific heat in excess of the electronic and lattice contribution, $C/R = 4.0 \times 10^{-4}/T^2$, is not in complete agreement with the value suggested by the anisotropy of the γ -ray emission of metallic cobalt. The small molar volume of cobalt metal gives rise to a hyperfine coupling specific heat per unit volume comparable to the specific heats of paramagnetic salts and has led to the suggestion that cobalt or other similar metals will be very effective as low temperature heat reservoirs. Below 0.1°K an observable anomaly is expected in iron, nickel, etc. (Contractor's abstract)

OSU.16:001

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

STATISTICAL THEORY OF LATTICE DISTORTION—ITS EFFECT ON ORDERING, by T. Usui. June 1958, 13p. (Technical note no. 1) (AFOSR-TN-58-995) (AF 49(638)-264) AD 205903 Unclassified

The effect of difference in atomic size between two components of a simple binary solid solution on the ordering is investigated by assuming a lattice distortion of the type expected in an elastic medium. Statistical conclusions are based on molecular field and quasi-chemical approximations. It is found that the critical temperature is always lowered compared to the case without distortion and that the degree of short range order at the critical temperature also decreases. (Contractor's abstract)

OSU.16:002; OSU.17:001; OSU.18:001

OSU.16:002

Ohio State U. Research Foundation. [Dept. of Physics and Astronomy] Columbus.

DISPERSION OF ELECTRON WAVES IN A RANDOM LATTICE (Abstract), by J. Korringa. [1958] [1]p. [AF 49(638)264] Unclassified

Presented at Kamerlingh Onnes Conf. on Low Temperature Physics, Leyden (Netherlands), June 23-28, 1958.

Published in Physica, v. 24: S171, Sept. 1958.

The residual resistance of an imperfect metal, though commonly obtained from a transport equation, appears as the imaginary term in the dispersion relation for electrons in the perturbed lattice. This dispersion theory is sketched for the special case that two atomic species, A and B, are randomly distributed in an otherwise perfect lattice, in concentrations C_A and C_B . The

basic results are: (1) The stationary states closely resemble Bloch waves; in two cells occupied by A-atoms the wave function differs mainly by a phase factor; the same holds for B-cells. The phase difference is of the form $k \cdot R_{ij} + \eta_{ij}$, where R_{ij} is the vector distance between the two lattice points, and where η_{ij} is a "phase error." For fixed R_{ij} , the phase errors have a Gaussian

distribution, with a width $\sigma_{ij} = \sqrt{\sigma} R_{ij}$. (2) The value of $\alpha(k)$ together with the energy $E(k) = \hbar^2 k^2 / 2m$, appear together as a complex eigenvalue of Schroedinger's equation in a periodic, but complex and velocity-dependent potential. The scattering matrix, corresponding to this potential in any lattice cell, is given by $U = (1 - i\alpha/k_0)(C_A U_A + C_B U_B)$, where U_A and U_B are the scattering matrices corresponding to the real potentials in an A- and B-cell, respectively. The latter can be obtained by a self-consistent iteration method. The value of α for states at the Fermi level is proportional to the resistance tensor; the function $k_0^2(k)$ describes the band structure of the system. (Contractor's abstract)

Also published in Behavioral Science, v. 4: 19-28, Jan. 1959.

Also published in First Interdisciplinary Conf. on Decisions, Values and Groups, New Mexico U., Albuquerque, Summer 1957, New York, Pergamon Press, v. 1: 37-49, 1960.

How does the personality of the decision maker affect the rules which guide his decisions? Does a gambler normally bet in such a way so as to maximize expected gain? What is the relation between the objective probability of the event and the way this probability appears to the risk taker? A combination of clinical psychological methods and statistical methods reveals some interesting relations among background, inferred personality traits, and observed gambling behavior of people.

OSU.18:001

Ohio State U. Research Foundation. School of Optometry, Columbus.

CHARACTERISTICS OF A MODEL RETINAL RECEPTOR STUDIED AT MICROWAVE FREQUENCIES, by J. M. Enoch and G. A. Fry. Final rept. Aug. 1957, 53p. Incl. diagrs. table, refs. (AFOSR-TR-57-62) (AF 18(603)63) AD 136544 Unclassified

Presented at meeting of the Opt. Soc. of Amer., Columbus, Ohio, Oct. 17-19, 1957.

Also published in Jour. Opt. Soc. Amer., v. 48: 899-911, Dec. 1958.

A simplified microwave model of the human visual system was constructed in order to study the characteristics of model retinal receptors. A technique devised by O'Brien (Jour. Opt. Soc. Amer., v. 41: 882, 1951) was employed. In this study, two physical distributions, two wavelengths, and two detecting conditions were considered. The relative sensitivity and the directional sensitivity of a model retinal cone ellipsoid were determined when it was irradiated by a point source and when it was placed at several different positions in a diffraction pattern at or near the Gaussian image point. It was found that more energy was absorbed by the detector unit when the model was irradiated by the point source than when it was placed in the Fraunhofer diffraction pattern. Similarly, more energy was absorbed when a shorter wavelength was employed. It was found that the model antenna became more efficient as it was moved away from the center of the diffraction pattern. The direction of maximum sensitivity shifted as a function of the position of the model antenna in the diffraction pattern. Markedly different directional sensitivity patterns were obtained for different physical distributions, for different positions in those distributions, and for different wavelengths. The implications of these findings are discussed. (Contractor's abstract)

OSU.17:001

Ohio State U. Research Foundation. Dept. of Psychology, Columbus.

SOME PERSONALITY CORRELATES OF DECISION MAKING UNDER CONDITIONS OF RISK, by A. Scodel, P. Ratoosh, and J. S. Minas. [1958] [13]p. Incl. tables, refs. (In cooperation with New Mexico U., Albuquerque) (AFOSR-TN-58-346) (AF 49(638)317 and AF 49(638)33) AD 154251 Unclassified

OHU.01:001-004; OKA.01:003

OHU.01:001

Ohio U. Dept. of Chemistry, Athens.

REACTIONS OF DIOLEFINS AT HIGH TEMPERATURES. I. KINETICS OF THE CYCLIZATION OF 3,7-DIMETHYL-1,8-OCTADIENE, by W. D. Huntsman and T. H. Curry. Oct. 1957 [13]p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-57-524) (Also bound with its TR-58-79; AD 158358) (AF 18(600)546) AD 136508 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 2252-2254, May 5, 1958.

The cyclization of 3,7-dimethyl-1,6-octadiene at 382.5° and 409° is first order, and the rate is not affected by the presence of nitric oxide or ethylene oxide. The Arrhenius energy of activation is 35.2 kcal/mole and the entropy of activation is -18 e.u. An intramolecular mechanism is proposed. (Contractor's abstract)

OHU.01:002

Ohio U. Dept. of Chemistry, Athens.

REACTIONS OF DIOLEFINS AT HIGH TEMPERATURES. II. THE CYCLIZATION OF 1,8-OCTADIENE AND 7-METHYL-1,6-OCTADIENE, by W. D. Huntsman, V. C. Solomon, and D. Eros. Mar. 1958, 17p. incl. refs. (Technical note no. 2) (AFOSR-TN-58-328) (Also bound with its AFOSR-TR-58-79; AD 158358) (AF 18(600)546) AD 154232 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 5455-5458, Oct. 20, 1958.

1,6-Octadiene undergoes cyclization at 457° to give 1-methyl-cis-2-vinylcyclopentane, and under the same conditions 7-methyl-1,8-octadiene furnishes 1-methyl-cis-2-isopropenylcyclopentane. 1,6-Heptadiene fails to cyclize even at 500°. These results lend support to the intramolecular mechanism previously proposed for the thermal cyclization of 1,6-diolefins. (Contractor's abstract)

OHU.01:003

Ohio U. Dept. of Chemistry, Athens.

REACTIONS OF DIOLEFINS AT HIGH TEMPERATURES. III. REVERSIBLE DISSOCIATION AND CYCLIZATION OF 1,5-DIOLEFINS, by W. D. Huntsman. July 1958, 9p. incl. refs. (Technical note no. 3) (AFOSR-TN-58-542) (Also bound with its TR-58-79; AD 158358) (AF 18(600)546) AD 158359 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 6389-6392, Dec. 20, 1960 (Title varies).

The reaction of 2-methyl-1,5-hexadiene when heated to 480°C and the formation of this product from other diolefins has been interpreted in terms of a reversible dissociation which yields only allyl radicals. It is found that 1,5-heptadiene behaves in a radically different manner upon pyrolysis, in which isomeric methylcyclohexenes and toluene are formed. The cyclization process is interpreted in terms of a free radical chain mechanism. (Contractor's abstract)

OHU.01:004

Ohio U. Dept. of Chemistry, Athens.

REACTIONS OF DIOLEFINS AT HIGH TEMPERATURES, by W. D. Huntsman. Final technical rept. July 1958, 27p. incl. tables, refs. (AFOSR-TR-58-79) (AF 18(600)548) AD 158358 Unclassified

A summary of the reactions of various 1,5- and 1,8-diolefins at temperatures of 400° to 500°C is given. 1,6-Diolefins having at least one hydrogen-bearing substituent undergo cyclization to give cyclopentane derivatives. An intramolecular mechanism is proposed for this type of cyclization. The kinetics of cyclization of 3,7-dimethyl-1,8-octadiene and the failure of free radical chain initiators and inhibitors to affect the rate of reaction lend support to the proposed mechanism. Additional support is provided by the fact that 1,8-octadiene and 7-methyl-1,6-octadiene undergo cyclization to give 1-methyl-cis-2-vinylcyclopentane and 1-methyl-cis-2-isopropenylcyclopentane, respectively, whereas 1,8-heptadiene fails to cyclize. Two types of reactions are observed when 1,5-diolefins are subjected to high temperatures. The first of these involves a reversible dissociation furnishing allyl-type radicals; 1,5-hexadiene, 2-methyl-1,5-hexadiene, 2,5-dimethyl-1,5-hexadiene and 6-methyl-1,5-heptadiene exhibit this type of behavior. The second type of reaction involves cyclization giving cyclohexene derivatives; 1,5-heptadiene exhibits this type of behavior. A free radical chain mechanism is proposed for this reaction. (Contractor's abstract)

Oklahoma A. and M. Coll., Stillwater.
(name changed to Oklahoma State U., Stillwater in 1957)

OKA.01:003

Oklahoma A. and M. Coll., Stillwater.

RECTIFICATION AND PHOTOVOLTAIC EFFECT IN SEMICONDUCTING DIAMOND (Abstract), by M. D. Bell and W. J. Leivo. [1957] 1p. (AFOSR-TN-57-156) [AF 18(603)40] AD 126448 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

OKA.01:004 - OKA.01:006

Also published in Bull. Amer. Phys. Soc., Series II, v. 2: 171, Apr. 25, 1957.

Rectification effects between metal points and Type IIb diamonds have been studied under various conditions. Rectification was observed with each of the metals tested which included indium, aluminum, copper, tungsten, silver, and platinum. The current-voltage characteristics were in qualitative agreement with rectification theory; however, there was no quantitative agreement because the reverse saturation current was not dependent upon the work function of the metal to the extent required by theory. The lack of dependence of rectification with the work function can be explained by Bardeen's theory of surface states. Reverse breakdown occurred between 30 and 60 volts and a luminescence was observed with 45 volts forward bias. Good rectification curves were still obtained at 300°C, the maximum temperature employed. The diamond developed photovoltages in the visible and near infrared extending from 310 mμ to 1.3μ with the maximum at 660 mμ. In the ultraviolet the photovoltage peaked at 230 mμ. (Contractor's abstract)

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 114, Mar. 27, 1958.

Studies have been made of the photoconductivity in semiconducting diamond as a function of the wavelength, temperature, electric field strength, intensity of incident radiation, and crystal orientation. At room temperature the region of photoconductivity is broad, extending from 0.375 to 2.1μ with the maximum at 0.6μ. Peaks also occur at 0.224 and 0.228μ. At lower temperatures various peaks in photoconductivity can be resolved. Maxima in photoconductivity at 152°K occur at 0.52, 0.92, 1.24, 1.64, and 2.16μ. The maxima in photoconductivity shift to shorter wavelengths and decrease in magnitude with decreasing temperature. Above room temperature the photoconductivity increases with increasing temperature to approximately 400°K after which it commences to decrease. The photoconductivity is linear with respect to electric field strength, and it is also linear with respect to the intensity of the incident radiation. A good signal-to-noise ratio can be obtained. The photoconductivity has a slight directional dependence. The photoconducting diamonds used in these experiments were furnished by J. F. H. Custers.

OKA.01:004

Oklahoma State U., Stillwater.

RECTIFICATION, PHOTOCONDUCTIVITY, AND PHOTOVOLTAIC EFFECT IN SEMICONDUCTING DIAMOND, by M. D. Bell and W. J. Leivo. Sept. 1958, 24p. incl. diagrs. table. (Technical rept. no. 1) (AFOSR-TN-58-381) (AF 18(603)40) AD 211034 Unclassified

Also published in Phys. Rev., v. 111: 1227-1231, Sept. 1, 1958.

Studies of the rectification between a metal point and p-type semiconducting diamond show that the formation of the potential barrier is essentially independent of the work function of the metal and is formed by the establishment of equilibrium between charges in surface and interior states. The semiconducting diamonds have been found to be photoconducting in the ultraviolet and visible regions. Agreement has been found between the spectral response of photoconductivity and photovoltages developed at metal contacts, with the exception that photovoltages developed near 440 mμ were not obtained in photoconductivity. (Contractor's abstract, modified)

OKA.01:005

Oklahoma State U., Stillwater.

PHOTOCONDUCTIVITY IN SEMICONDUCTING DIAMOND (Abstract), by C. C. Johnson and W. J. Leivo. [1958] [1]p. (AF 18(603)40) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

OKA.01:006

Oklahoma State U., Stillwater.

LIFETIMES AND TRAPPING OF CARRIERS IN SEMICONDUCTING DIAMOND (Abstract), by J. H. Wayland and W. J. Leivo. [1958] [1]p. (AF 18(603)40) Unclassified

Presented at meeting of the Amer. Phys. Soc., Los Angeles, Calif., Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 400, Dec. 29, 1958.

Lifetimes and trapping of carriers in semiconducting diamond have been studied from the response and decay times of photoconductivity. The gem quality diamond investigated has a resistivity of 3.5×10^5 ohm cm and is photoconducting in the visible region. Hall measurements show p-type conductivity with a hole mobility of $1300 \text{ cm}^2/\text{volt sec}$. From the rise time of photocurrent, using light in the fundamental absorption region, a lifetime of 9μsec was obtained. This is possibly largely independent of trapping. From decay curves, lifetimes, which include trapping, of 125μsec, 800μsec, 0.25 sec, 12 min, and 84 min were obtained. Using visible light, the response and decay time of the photocurrent is dependent upon the wavelength of the exciting radiation because several intermediate energy levels are present in this region. Various recombination times obtained include 20 msec, 30 sec, 6 min, and 39 min.

OKA.02:003, 004; OKA.04:001, 002

OKA.02:003

Oklahoma A. and M. Coll. Dept. of Chemistry, Stillwater.

INVESTIGATIONS OF THE THERMODYNAMIC PROPERTIES OF INORGANIC SALTS IN NONAQUEOUS SOLVENTS AND IN CONCENTRATED SALT MIXTURES, by T. E. Moore. Final technical rept. July 1957, 49p. incl. diagrs. tables, refs. (AFOSR-TR-57-47) (AF 18-(600)478) AD 132477 Unclassified

Research was undertaken (1) to study the chemical potentials in the systems consisting of H_2O , HCl , and certain of the transition metal salts in concentrated solutions at $25^\circ C$; and (2) to examine new approaches to the problem of obtaining the activity of the solute and solvent in nonaqueous solutions. The thermodynamic activities of $MnCl_2$, HCl , and H_2O at $25^\circ C$ were measured in 3 series of mixtures having constant HCl concentrations of 4.67, 7.05, and 9.01 M, respectively. In each series, the $MnCl_2$ concentration was varied from 0.2 M to saturation. The HCl and H_2O vapor pressures were measured by the gas-transpiration method, and the activity of $MnCl_2$ was calculated from the Gibbs-Duhem relationship. The activities of HCl and $MnCl_2$ in the mixtures were very high in comparison with the corresponding activities in the binary solutions, partly because of higher chloride ion concentrations and ionic hydration. A similar study was made of the activities in the system, $MnSO_4-HCl-H_2O$ at an HCl concentration of 7.27 M. An investigation was made of the principle of the wet-bulb thermometer applied to the problem of measuring vapor-pressure lowerings of ether solutions; although the method could be used with an average error of less than 1%, measurements were tedious, and the behavior of the apparatus was unpredictable and erratic. The use was studied of IR spectrometry in the measurement of the vapor pressures of 2 volatile components in a 3-component mixture. Two novel manometers of high theoretical sensitivity were built and tested.

OKA.02:004

Oklahoma A. and M. Coll. [Dept. of Chemistry] Stillwater.

INVESTIGATION OF NOVEL STATIC METHODS FOR THE DETERMINATION OF VAPOR PRESSURES IN THE PRESENCE OF INDIFFERENT GASES, by C. E. Miller. May 1957, 46p. incl. diagrs. refs. (AFOSR-TR-57-47a) (AF 18(600)478) Unclassified

A novel static method for the determination of partial pressures in the presence of an indifferent gas which gives high sensitivity in the vapor pressure range of 0 to 25 mm Hg and which requires a short time for the determination is given. Campbell's procedure uses a liquid, previously saturated with an indifferent gas at

a definite temperature and pressure, to evaporate into a space containing the same gas, under the same conditions. A single piston and double piston gauge and a displacement weight manometer were built and tested for their applicability to the determination of vapor pressures of solutions following this procedure.

OKA.04:001

Oklahoma State U. Dept. of Chemistry, Stillwater.

THE HYDROLYSIS OF AMMONIUM CARBAMATE AND THE MECHANISM OF ACTION OF UREASE, by G. Gorin and M. F. Butler. Feb. 1958, 10p. incl. table, refs. (Technical note no. 1) (AFOSR-TN-58-518) (AF 18(603)-135) AD 158331; PB 135411 Unclassified

Presented at meeting of the Biological Div. of the Amer. Chem. Soc., New York, Sept. 8-13, 1957.

Abstract published in 132nd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 6-C.

The rate of hydrolysis of ammonium carbamate has been measured in 0.05-0.25 M sodium hydroxide and found to be proportional to the hydrogen in concentration. At this pH, the rate-determining step is the addition of a hydronium ion to the carbamate ion, giving ammonia and carbon dioxide. At pH 9, which is the value developed when ammonium carbamate hydrolyzes in the absence of added buffers, the hydration of carbon dioxide becomes the rate-determining step, and the half-life of the reaction is about 10-20 minutes at 0° ; under these conditions, the presence of ammonium carbamate in aqueous solutions can be demonstrated. In more acidic buffers, the rate of reaction increases again; in a phosphate buffer at pH 7, the reaction was substantially over in less than a minute. Urea hydrolyzed by urease in the presence of no added buffers largely produces carbamate which can be demonstrated analytically, but which subsequently hydrolyzes. In buffer at pH 7 the carbamate cannot be demonstrated, but the observations reported above explain why this would be so, even though carbamate was the first intermediate product. This is considered to be the most likely mechanism of the urease-catalyzed hydrolysis. However, it is possible that the carbamate would have arisen from recombination of ammonia and carbon dioxide, and that these might be the primary products of the urease-catalyzed reaction. (Contractor's abstract)

OKA.04:002

Oklahoma State U. Dept. of Chemistry, Stillwater.

THE REACTION OF CYSTINE WITH SODIUM SULFIDE IN SODIUM HYDROXIDE SOLUTION, by G. Gorin and G. S. Rao. Feb. 1958, 14p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-58-519) (AF 18-(603)135) AD 158332; PB 135410 Unclassified

OKA.04:003; OKU.02:001;
ORS.01:001, 002Also published in Jour. Org. Chem., v. 24: 749-753,
June 1959.

Reaction of cystine with sodium sulfide in 0.2 M sodium hydroxide solution produces a product with an absorption peak at 335 mμ; it is postulated that the species responsible for this absorption is $(-SSCH_2CHNH_2COO^-)$. In the presence of excess sulfide this species reacts further, and, over-all, there are produced two cysteinate ions and di- or polysulfide ions. Mixtures of cystine with 5-10 equivalents of sodium sulfide allowed to react to the point of equilibrium, have small but definite levorotations; upon being made acid, they contain little or no cystine. In the conditions indicated it appears that the first reaction producing RSS^- goes practically to completion, but that the subsequent reaction has a smaller equilibrium constant. The change of optical rotation in mixtures of cystine and sulfide was followed quantitatively, and approximate speeds of reaction were determined. Sodium sulfide might be useful for splitting disulfide groups in proteins, although there are considerable limitations to its potential utility. (Contractor's abstract)

OKA.04:003

Oklahoma State U. Dept. of Chemistry, Stillwater.

DETERMINATION OF MERCAPTO GROUPS IN OVALBUMIN WITH FERRICYANIDE, by J. M. Katyal and G. Gorin. [1958] [11]p. incl. diagrs. tables, refs. [AFOSR-TN-58-877] (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)135 and Public Health Service) AD 203911 Unclassified

Also published in Arch. Biochem. and Biophys., v. 82: 319-329, June 1959.

A precise determination of the mercapto-group content of denatured ovalbumin has been made with potassium ferricyanide in phosphate buffer at pH 7.1 by means of a novel amperometric method. The results indicate 4.0 groups per mol of 45,000 mol wt. This has been confirmed by spectrophotometric measurements. A qualitative measurement of the rate of reaction of ferricyanide with ovalbumin in the presence of trimethyldodecylammonium chloride and sodium dodecyl sulfate as denaturants has shown that the reaction proceeds much faster in the presence of the former.

OKU.02:001

Oklahoma U. Dept. of Physics, Norman.

PYREX DEMOUNTABLE PHOTOMULTIPLIER REFRIGERATOR, by C. J. Bronco, R. M. St. John, and R. G. Fowler. [1958] [2]p. incl. diagrs. [AF 49(638)41] Unclassified

Published in Rev. Scient. Instruments, v. 29: 1145-1146,
Dec. 1958.

The measurement of extremely small light fluxes photoelectrically requires the use of a multiplier phototube operated at the temperature of liquid air in order to reduce dark current components due to thermionic emission and cesium vapor pressure. It is desirable to operate the multiplier in a vacuum. The refrigerator should be demountable so the multiplier may be withdrawn for minor adjustments. A refrigerator is described that is easy to construct and whose plan can be simply adapted to any type and size tube. The refrigerator specifically described herein is all Pyrex (except the window) and is designed specifically for an EMI 6256B tube. This tube is 5 in. long and 2 in. in diameter; the photosensitive cathode is in the end.

ORS.01:001

Oregon State Coll., Corvallis.

A LIMIT THEOREM AND THE DISTRIBUTION OF THE STOCHASTIC INTEGRAL, by D. L. Clark. Sept. 1, 1957 [49]p. (Technical rept. no. 2) (AFOSR-TN-58-719) (AF 18(603)138) AD 162254 Unclassified

A generalized discussion on convergence of random variables is presented. Given a convergent array X whose limit is separable, find the conditions on the set of constants $\{a_{nk}, 1 \leq k \leq k_n, n \geq 1\}$ such that the corresponding transformed array X^* will be convergent. The cases considered are those where X converges uniformly and where the functions

$$a_n(t) = \begin{cases} a_n, [k_n t] + 1, 0 \leq t < 1 \\ a_{nk_n}, t = 1 \end{cases}$$

converge to a function $a(t)$ of bounded variation on $(0, 1)$.

ORS.01:002

Oregon State Coll., Corvallis.

LIMIT THEOREMS FOR THE DISTRIBUTIONS OF THE MAXIMA OF PARTIAL SUMS OF INDEPENDENT RANDOM VARIABLES, by E. G. Kimme. Sept. 1, 1957, 95p. (Technical rept. no. 1) (AFOSR-TN-58-720) (AF 18(603)138) AD 162255 Unclassified

Limit theorems have been used to establish analytic formulations for the functional distributions of sample functions of a stochastic process. Results are given in terms of the distributions of the sample values. Implicit relations appear as integral equations involving the limiting distribution of the distributions of the maxima. These limiting distributions are regarded as the distributions

OSL 01:001; OXF 01:002, 003

of functionals defined on limiting stochastic processes. A resolvent function is obtained for the characteristic function of the supremum functional under certain hypotheses beyond those of the convergence of the sums in distribution. Smoothness hypotheses provide an integral equation for the distributions which is similar to the integral equations in the theory of Markov processes and recurrent events. General convergence theorems are discussed and a summary of results are presented. Asymptotic formulas, primarily unsolved integral equations, relating to the distribution of the supremum functional are developed. The appendix consists of an elementary extension of the Helly convergence theorem.

OSL 01:001

Oslo U. (Norway).

CRYSTAL STRUCTURE OF THE 1:1 ADDITION COMPOUND FORMED BY ACETONE AND BROMINE, by O. Hassel and K. O. Strømme. [1958] [8]p. incl. diagrs. tables. (AFOSR-TN-58-1066) (AF 81(052)71) AD 207228 Unclassified

Also published in *Acta Chemica Scandinavica*, v. 13: 275-280, 1959.

The crystal structure of the equimolecular compound containing acetone and bromine has been determined at temperatures near -30°C using Weissenberg technique (CuK-radiation) and precession technique (MoK-radiation). The space group is C2/c and the lattice parameters: $a = 7.12 \text{ \AA}$; $b = 7.48 \text{ \AA}$; $c = 12.90 \text{ \AA}$; $\beta = 111.5^{\circ}$. Endless chains are present in this structure, bromine atoms and the carbonyl carbon and oxygen atoms of each chain being coplanar. Each oxygen atom is linked to two neighboring oxygen atoms of the same chain by halogen molecule bridges and the $\text{O}-\text{Br}-\text{Br}-\text{O}$ arrangements are linear. The observed $\text{Br}-\text{Br}$ distance was found equal to the distance observed in free bromine molecules (2.28 \AA), the $\text{O}-\text{Br}$ distance 2.82 \AA . This structure affords the first example of two halogen molecule bridges starting from a common oxygen atom.

OXF 01:002

Oxford U. Dept. of Biochemistry (Gt. Brit.).

SYNTHESIS OF CELL CONSTITUENTS FROM C_2 -UNITS BY A MODIFIED TRICARBOXYLIC ACID CYCLE, by H. L. Kornberg and H. A. Krebs. [1957] [4]p. incl. diagrs. refs. [AF 61(514)1180] Unclassified

Published in *Nature*, v. 179: 988-991, May 18, 1957.

Recent work has established the occurrence of a metabolic cycle in microorganisms which can derive all their carbon requirements from two-carbon compounds.

The cycle, representing a variant of the tricarboxylic acid cycle, is referred to as the "glyoxylate cycle". The main discoveries which led to the elaboration of the cycle were: (1) the finding that isocitrate, apart from undergoing dehydrogenation, is split enzymically to form succinate and glyoxylate; (2) the recognition of an enzyme system bringing about the synthesis of malate from glyoxylate and acetyl coenzyme A; and (3) the demonstration of the ready occurrence of the combined action of the two enzyme systems in cell-free extracts. The overall effect of one turn of the glyoxylate cycle is the formation, from two molecules of acetate, of one molecule of C_4 -dicarboxylic acid. The cycle is therefore a stage in the synthesis of cell material from acetate, and can account for the net formation from acetate of citric, fumaric and other organic acids in molds, and the conversion of fat to carbohydrate in *Ricinus* seedlings. (Contractor's abstract, modified)

OXF 01:003

Oxford U. Dept. of Biochemistry (Gt. Brit.).

ACETATE METABOLISM IN ACETATE-GROWN *PSEUDOMONAS* KB 1, by H. L. Kornberg. [1957] [1]p. [AF 61(514)1180] Unclassified

Presented at meeting of the Biochem. Soc., Oxford (Gt. Brit.), Apr. 12-13, 1957.

Published in *Biochem. Jour.*, v. 66: 13P, June 1957.

Pseudomonas KB 1 grows rapidly on synthetic media containing acetate as sole carbon source. The tricarboxylic acid cycle seems to operate in the acetate media as when cells are grown on succinate. This is also supported by degradative studies of labeled amino acids synthesized by organisms grown on $[\text{C}^{14}]$ acetate. When growing cells are incubated with $\text{C}^{14}\text{H}_3\text{COONH}_4$, label appears initially (3-30 sec) only in intermediates of the cycle and in amino acids directly derived therefrom. Mechanisms such as those operating in photosynthetic or autotrophic organisms are not of primary importance. A compound, probably oxaloacetate, occurs in ready equilibrium with CO_2 at an early stage in the metabolism of acetate. When microorganisms grow on acetate as sole carbon source, rapid net synthesis of C_4 -dicarboxylic acids must occur from acetate to provide the acceptor for C_2 units entering the cycle. The high initial radioactivity of C_4 compounds suggests that acetate enters the cycle at least at two sites: citrate forms at one and direct C_4 compounds form at the other. (Contractor's abstract, modified)

OXF.01:004 - OXF.01:006

OXF.01:004

Oxford U. Dept. of Biochemistry (Gt. Brit.).

FORMATION OF C_4 -DICARBOXYLIC ACIDS FROM ACETATE BY PSEUDOMONAS KB 1, by H. L. Kornberg and N. B. Madsen. [1957] [2]p. [AF 61(514)1180]
Unclassified

Presented at meeting of the Biochem. Soc., Oxford (Gt. Brit.), Apr. 12-13, 1957.

Published in Biochem. Jour., v. 66: 13P-14P, June 1957.

Experiments with cell-free extracts of Pseudomonas KB 1 were undertaken to elucidate the mechanism by which net syntheses of C_4 -dicarboxylic acids from acetate are achieved in these organisms. Acetate-grown Pseudomonas KB 1 cells were crushed by the Hughes method, homogenized with 0.1 M potassium phosphate, pH 7.6, and centrifuged at 25,000 g. When this supernatant fraction was incubated with isocitrate, $C^{14}H_3COONa$, coenzyme A, ATP, and glutathione, labeled malate was formed. This incorporation of C^{14} also occurred when glyoxylate replaced isocitrate in the above system, but no isotope was incorporated in the absence of enzyme, ATP, glyoxylate or isocitrate. The net formation of malate from acetate and glyoxylate by extracts in the presence of ATP, coenzyme A, and glutathione under anaerobic conditions was also demonstrated. The presence of an enzyme similar to, or identical with, the malate synthetase of Wong and Aji was indicated. It was concluded that the cells of acetate-grown Pseudomonas KB 1 contain all the enzymes necessary to effect the net synthesis of C_4 -dicarboxylic acids by the following reactions:

isocitrate - succinate + glyoxylate,
acetate + ATP + coenzyme A - acetyl-coenzyme A (+AMP+PP),
acetyl-coenzyme A + glyoxylate - malate + coenzyme A,

the net result being:

acetate + isocitrate + ATP - malate + succinate (+AMP+PP).

OXF.01:005

Oxford U. Dept. of Biochemistry (Gt. Brit.).

SYNTHESIS OF C_4 -DICARBOXYLIC ACIDS FROM ACETATE BY A "GLYOXYLATE BYPASS" OF THE TRICARBOXYLIC ACID CYCLE, by H. L. Kornberg and N. B. Madsen. [1957] [3]p. incl. diagrs. tables, refs. (AF 61(514)1180)
Unclassified

Published in Biochim. et Biophys. Acta, v. 24: 651-653, June 1957.

Pseudomonas KB 1, when grown on acetate as sole source, possesses, in addition to the enzymic reactions of the tricarboxylic acid cycle, an auxiliary mechanism which provides an alternative route from isocitrate to malate. This route is monoxidative and consists of the cleavage of isocitrate by isocitritase and the condensation of acetyl CoA and glyoxylate by malate synthetase. The result of this "glyoxylate bypass" is the formation of two C_4 -dicarboxylic acids from isocitrate and acetate.

If this bypass is used instead of the oxidative reactions of the tricarboxylic acid cycle, one turn of the cycle results in the net formation of one molecule of C_4 -dicarboxylic

acid from two molecules of acetate. A reaction of this type was first postulated by Thunberg, but the evidence for its occurrence has been disputed. The overall effect of reaction plus the reactions of the tricarboxylic acid cycle leading to the synthesis of isocitrate and to the regeneration of oxalacetate is identical with that of the "Thunberg condensation" although the mechanism is entirely different.

OXF.01:006

Oxford U. Dept. of Biochemistry (Gt. Brit.).

QUANTITATIVE ASPECTS OF CO_2 FIXATION DURING PROTEIN SYNTHESIS FROM AMMONIUM ACETATE, by H. L. Kornberg. [1957] [3]p. incl. diagr. table, refs. (AF 61(514)1180)
Unclassified

Published in Biochim. et Biophys. Acta, v. 25: 200-202, July 1957.

Microorganisms, growing on synthetic media containing ammonium acetate as sole C source, rapidly incorporate isotope from added $C^{14}H_3COONH_4$ into protein. In the presence of unlabeled $NaHCO_3$, this synthesized protein is less radioactive than in its absence. Short-term experiments indicate that the protein initially synthesized under such conditions may derive as much as 70% of its C from the unlabeled bicarbonate. These results could be explained either by the occurrence of a CO_2 -fixation reaction of hitherto unsuspected magnitude, or by an increase in the steady-state concentration (due to the addition of bicarbonate) of a compound in ready equilibrium with CO_2 lying on one of the earliest stages of the pathway from acetate to protein. Experiments with Pseudomonas RB1³ support the latter explanation.

OXF.01:007 - OXF.01:011

OXF.01:007

Oxford U. Dept. of Biochemistry (Gt. Brit.).

QUANTITATIVE DETERMINATION OF 0.5-5 μ g OF AMINO ACID NITROGEN ON PAPER CHROMATOGRAMS AND IN SOLUTION, by H. L. Kornberg and W. E. Patey. [1957] 5p. Incl. diagrs. table. (AF 61-514)1180) Unclassified

Published in *Biochim. et Biophys. Acta*, v. 25: 189-193, July 1957.

A method is described for the rapid quantitative micro-determination of amino acids on paper chromatograms and in solutions. Its main advantage is that the interference of ammonia is eliminated by the use of buffered Dowex-50. Quantities of amino acids containing between 0.05 and 5 μ g of α -amino nitrogen can be determined. The accuracy of a single determination is of the order of $\pm 5\%$ at levels of 0.05-1 μ g N, but $\pm 2\%$ when quantities of 1.5-5 μ g N are determined. (Contractor's abstract)

OXF.01:008

Oxford U. Dept. of Biochemistry (Gt. Brit.).

A MECHANISM OF CONVERSION OF FAT TO CARBOHYDRATE IN CASTOR BEANS, by H. L. Kornberg and H. Bevers. [1957] [2]p. Incl. illus. table. (AF 61(514)-1180) Unclassified

Published in *Nature*, v. 180: 35-36, July 6, 1957.

The possible occurrence of the "glyoxylate by-pass" in castor beans was investigated in an attempt to account for the conversion of fat to carbohydrate, known to occur in germinating fatty seedlings. Cell-free extracts of the endosperm and cotyledons of castor bean seedlings were prepared and incubated with isocitrate, C¹⁴-labeled acetate, coenzyme A, glutathione, and adenosine triphosphate. Analysis of the samples indicated that malate was the only labeled compound formed. This production of malate indicates that the glyoxylate by-pass operates in castor beans and provides both a route for the interconversion of fat and carbohydrate and information on the origin of glycolic acid in this tissue.

OXF.01:009

Oxford U. Dept. of Biochemistry (Gt. Brit.).

THE GLYOXYLATE CYCLE AS A STAGE IN THE CONVERSION OF FAT TO CARBOHYDRATE IN CASTOR BEANS, by H. L. Kornberg and H. Bevers. [1957] [7]p. Incl. diagrs. tables, refs. (AF 61(514)1180) Unclassified

Published in *Biochim. et Biophys. Acta*, v. 26: 531-537, Dec. 1957.

Cell-free supernatant fractions of castor beans catalyzed the following reactions: The aldol fission of isocitrate, to produce equal amounts of glyoxylate and succinate; the activation of acetate in the presence of CoA and ATP; the condensation of acetyl CoA with oxaloacetate, to form citrate, and with glyoxylate, to form malate; the overall formation of malate from acetyl CoA and esterase citrate or isocitrate. These reactions of the glyoxylate cycle, when coupled with the reactions leading from fat to acetyl CoA, and from malate to carbohydrate, provide a route for the net conversion of fat to carbohydrate.

OXF.01:010

Oxford U. Dept. of Biochemistry (Gt. Brit.).

THE GLYOXYLATE CYCLE IN ASPERGILLUS NIGER, by H. L. Kornberg and J. F. Collins. [1958] [2]p. Incl. refs. [AF 61(514)1180] Unclassified

Published in *Biochem. Jour.*, v. 68: 3P-4P, Apr. 1958.

Experiments were performed to investigate the occurrence of the glyoxylate cycle in *Aspergillus* extracts. Cell-free extracts contain aceto-CoA-kinase and form [C¹⁴]acetyl coenzyme A in the presence of ATP, coenzyme A, MgCl₂, glutathione and [C¹⁴]acetate. When this system is incubated with intermediates of the tricarboxylic acid cycle, major incorporation of isotope from acetate occur only with oxaloacetate, forming labeled citrate, and with isocitrate, forming labeled malate. These results indicate the occurrence of the glyoxylate cycle.

OXF.01:011

Oxford U. Dept. of Biochemistry (Gt. Brit.).

THE METABOLISM OF C₂ COMPOUNDS IN MICRO-ORGANISMS. I. THE INCORPORATION OF [2-C¹⁴] ACETATE BY PSEUDOMONAS FLUORESCENS, AND BY A CORYNEBACTERIUM, GROWN ON AMMONIUM ACETATE, by H. L. Kornberg. [1958] [8]p. Incl. diagrs. table, refs. (AF 61(514)1180) Unclassified

Published in *Biochem. Jour.*, v. 68: 535-542, Mar. 1958.

Washed cells of *Pseudomonas fluorescens*, grown on acetate as sole carbon source, rapidly oxidized acetate and all tricarboxylic acid cycle intermediates, confirming the occurrence of this cycle in this organism.

The distribution of isotope, incorporated from [C¹⁴] acetate in short-term incubations (3 sec-5 min) indicates that acetate enters the cycle at two sites, to form

OXF.01:012 - OXF.01:015

malate at one point and citrate at the other. These findings are in accordance with the operation in intact cells of the "glyoxylate by-pass" of the tricarboxylic acid cycle, demonstrated in cell extracts.

OXF.01:012

Oxford U. Dept. of Biochemistry (Gt. Brit.).

THE METABOLISM OF C_2 COMPOUNDS IN MICRO-ORGANISMS. II. THE EFFECT OF CARBON DIOXIDE ON THE INCORPORATION OF $[C^{14}]$ ACETATE BY ACETATE-GROWN *PSEUDOMONAS* KB 1, by H. L. Kornberg and J. R. Quayle. [1958] [8]p. Incl. diagrs. tables, refs. (AF 61(514)1180) Unclassified

Published in *Biochem. Jour.*, v. 68: 542-549, Mar. 1958.

The effect of non-radioactive carbon dioxide on the incorporation of C^{14} into protein synthesized from ammonium $[C^{14}]$ acetate by *Pseudomonas* KB 1 has been studied. Addition of unlabeled bicarbonate to cells growing on ammonium $[C^{14}]$ acetate depressed the initial rate of incorporation of C^{14} into protein. Cells growing on a stream of unlabeled CO_2 synthesized protein of specific activity 15-17% lower than those growing in the absence of unlabeled CO_2 . The presence of $C^{12}O_2$ did not affect the distribution of isotope within the synthesized alanine, but caused a uniform reduction of radioactivity in the carboxyl carbons of aspartate. The observed labeling patterns, which show that CO_2 -fixation plays no part in the synthesis of alanine but participates in that of aspartate, provide evidence for the occurrence of the glyoxylate cycle in these organisms. (Contractor's abstract, modified)

OXF.01:013

Oxford U. Dept. of Biochemistry (Gt. Brit.).

THE METABOLISM OF C_2 COMPOUNDS IN MICRO-ORGANISMS. III. SYNTHESIS OF MALATE FROM ACETATE VIA THE GLYOXYLATE CYCLE, by H. L. Kornberg and N. B. Madsen. [1958] [9]p. Incl. diagrs. refs. (AF 61(514)1180) Unclassified

Published in *Biochem. Jour.*, v. 68: 549-557, Mar. 1958.

Reactions of acetate were studied in cell-free extracts of acetate-grown *Pseudomonas* KB 1. Such extracts are capable of catalyzing the formation of acetyl-coenzyme A from acetate. Acetyl-coenzyme A thus formed reacts both with oxaloacetate, to form citrate, and with glyoxylate to form malate. By the use of extracts from

mutant M 22-64 of *Escherichia coli*, it has been shown that these condensations are catalyzed by different enzymes. The aldol fission of isocitrate, to succinate and glyoxylate, can provide the glyoxylate necessary for the formation of malate. The cell-free extracts catalyze the net anaerobic formation of malate and succinate from acetate and isocitrate. These reactions, in conjunction with the reactions leading from acetate to citrate, from citrate to isocitrate and from malate to oxaloacetate, shown to occur in the bacterial extracts, represent a synthesizing variant of the tricarboxylic acid cycle leading to the formation of one molecule of C_4 dicarboxylic acid from two molecules of acetate. The rate of formation of malate from acetate and isocitrate is at least 3 μ mol/hr/extract from 1 mg dry wt of bacteria. Since malate is known to be a precursor of most cell constituents, this rate is sufficiently high to account for the observed rates of growth of *Pseudomonas* KB 1 on ammonium acetate. The bacterial extracts also catalyze an interconversion of malate with pyruvate and carbon dioxide that is linked with triphosphopyridine nucleotide. (Contractor's abstract)

OXF.01:014

Oxford U. Dept. of Biochemistry (Gt. Brit.).

CARBON DIOXIDE AND FORMATE UTILIZATION BY FORMATE-GROWN *PSEUDOMONAS OXALATICUS*, by J. R. Quayle and D. B. Keech. [1958] [3]p. Incl. diagrs. table. (AF 61(514)1180) Unclassified

Published in *Biochim. et Biophys. Acta*, v. 20: 223-225, July 1958.

Isotopic experiments have been performed with formate-grown *P. oxalaticus* demonstrating a pathway of CO_2 fixation via ribulose-1,5-diphosphate, RuDP. Resulting data suggest a CO_2 -fixation cycle similar to that found in photosynthetic tissue and chemosynthetic lithotrophic bacteria. This represents a major pathway for fixation of formate carbon into cell constituents. The conclusion was substantiated by the use of cell-free extracts.

OXF.01:015

Oxford U. Dept. of Biochemistry (Gt. Brit.).

EFFECT OF GROWTH SUBSTRATES ON ISOCITRATASE FORMATION BY *PSEUDOMONAS OVALIS* CHESTER, by H. L. Kornberg, A. M. Gotto, and P. Lund. [1958] [2]p. Incl. diagrs. table, refs. (AF 61(514)1180) Unclassified

Published in *Nature*, v. 182: 1430-1431, Nov. 22, 1958.

P. ovalis synthesizes isocitratase at a rate parallel to the formation of cellular material. Isocitratase is also

OXF.02:001 - OXF.02:002

formed when there is a need within the cell for C_4 compounds from acetate, and this formation of isocitratase precedes growth on acetate.

OXF.02:001

Oxford U. [Engineering Lab.] (Gt. Brit.).

AN S-BAND FERRITE ISOLATOR FOR USE WITH A LINEAR ACCELERATOR. [1958] [4]p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-58-654) (AF 61-(514)1183) AD 162185; PB 138108 Unclassified

A ferrite isolator that handles 1 megawatt of S-band is described. Results that show the great advantage of using an isolator when operating a magnetron with a narrow bandwidth load are given. It is pointed out that the use of isolators gives designers of electron accelerators freedom to use very high Q or variable impedance devices. (Contractor's abstract)

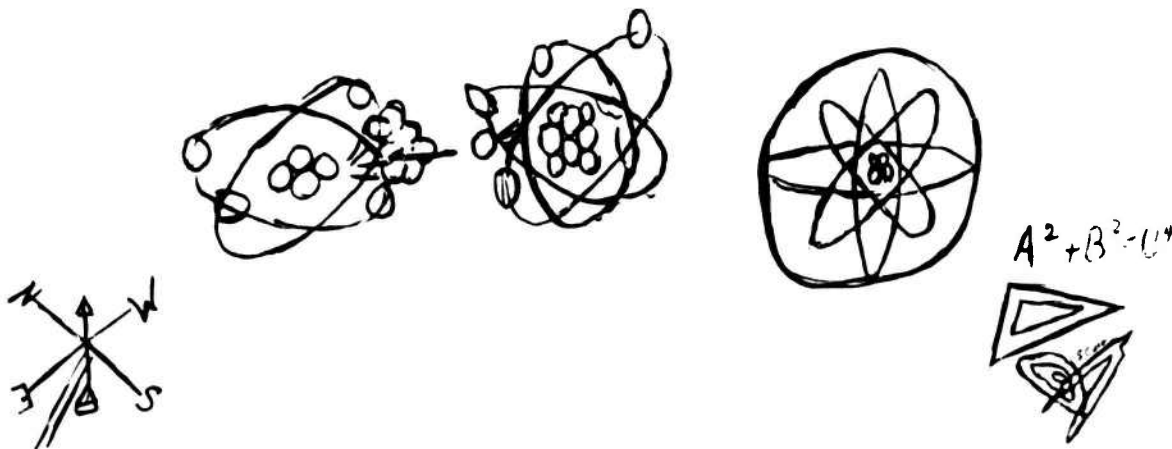
OXF.02:002

Oxford U. Engineering Lab. (Gt. Brit.).

CONTRIBUTION OF HIGH-ENERGY PARTICLES TO THERMONUCLEAR REACTION RATES, by G. Eder and H. Motz. [1958] [3]p. incl. diagrs. tables, refs. [AF 61-(514)1183] Unclassified

Published in Nature, v. 182: 1140-1142, Oct. 25, 1958.

Results concerning thermonuclear reaction-rates are presented which show in detail the contribution of particles of various energy groups to the total reaction-rates. In all cases considered, the main contribution was found to come from a rather small number of particles with energy much higher than the mean thermal energy of the particles. These results point to the possibility of rising acceleration processes within a gas discharge for the purpose of production of fusion power. The Harwell results indicate that the neutron yield of ZETA is in fact due to non-equilibrium processes.



PAC.01:001, 002; PAL.01:001

PAC.01:001

Pacific Semiconductors, Inc., Culver City, Calif.

RESEARCH ON SOLID STATE DIFFUSION IN SEMI-CONDUCTOR MATERIALS, by T. J. La Chapelle. Final technical rept. Aug. 1, 1956-July 31, 1957. Sept. 1957, 62p. incl. illus. diagrs. tables, refs. (Rept. no. 3000:5-5-F) (AFOSR-TR-57-63) (AF 18(603)117) AD 136553 Unclassified

Dislocation arrays appear to play a more important role in the solid-state diffusion of impurities into silicon than dislocation density. Several new pit patterns produced by the Dash etch technique are reported and photographs of these are shown. Distribution of impurities appears to be much more structure sensitive than do diffusion rates. An error function complement distribution seems to be closely followed by boron diffusion into silicon under reducing conditions. Silicon surface preparation and properties have been investigated in their relation to diffusion. Flat, damage-free surfaces have been produced by the use of garnet abrasives and special etches. Surface damage of less than a μ appeared to give a 20% faster diffusion rate than an etched surface for a penetration depth of about 90 μ . Junction staining techniques consistently have given 10% higher values for diffusion depth than the sheet resistance and incremental lapping method. The effects of diffusion and heat treatment were studied as they relate to the resistivity, minority carrier lifetime, and structural perfection of silicon. Both p- and n-type silicon showed resistivity increases; the former indicated donor increases up to 10^{15} cm^{-3} , the latter gave acceptor increases in the $10^{13} - 10^{14} \text{ cm}^{-3}$ range. Lifetime after diffusion at 1200°C was severely degraded to less than 1 μsec in most instances, although 6 - 12 μsec were retained in one sample after a particular heating cycle. The structure of diffused silicon appears to be far more imperfect than either heat-treated silicon or virgin (as grown) silicon. Known impurity-dislocation interaction and preliminary experiments suggest that contaminants in raw silicon are still an unknown variable. (Contractor's abstract)

PAC.01:002

Pacific Semiconductors, Inc., Culver City, Calif.

RESEARCH ON SOLID STATE DIFFUSION IN SEMI-CONDUCTOR MATERIALS, by T. J. La Chapelle. Final technical rept. II. Aug. 1, 1957-July 31, 1958, 52p. incl. illus. diagrs. table, refs. (Rept. no. 3000:5-10-F) (AFOSR-TR-58-122) (AF 18(603)117) AD 202923; PB 137815 Unclassified

A continuation of research (see item no. PAC.01:001) has indicated the relationships between structural perfection and the diffusion of impurities into the silicon lattice. High purity p-type Czochralski pulled ingots as

well as floating zone silicon were used in the studies. Diffusion of phosphorus from the elemental form was carried out at 1039, 1105 and 1155°C using a specially constructed Kanthal furnace. High precision techniques are described which were used for carrying out the analyses of incremental lapping and 4-point probe resistivity measurements of 3, 5 and 16 μ deep diffusions. Considerable effects on diffused junction depths were seen for a floating zone sample containing a high density of low angle tilt boundaries. All silicon having surface damage, in spite of careful lapping, produced abnormal impurity distributions which could not be matched to the expected error function complement curves. Etched, supposedly damage-free surfaces were still characterized by flatter impurity concentration vs. depth profiles than predicted, though not as pronounced as the unetched. In general, the diffusion coefficients for the μ -thin runs seemed to be at least a factor of 2 or 3 higher than the current literature. (Contractor's abstract)

PAL.01:001

Palermo U. Inst. of Physics (Italy).

CRYSTAL PLASTICITY. I. A THEORY OF GLIDE IN METAL CRYSTALS, by D. A. Aboav. Dec. 31, 1957, 61p. incl. diagrs. refs. (Technical note no. 1) (AFOSR-TN-58-170) (AF 61(514)1078) AD 152197 Unclassified

The object of this research was to seek a simple theory of glide in metal crystals. The known facts were first classified and an attempt made to distinguish the simple, or fundamental, facts from those attributable to secondary causes. It became apparent that, while many of the characteristic glide phenomena can be attributed to a break-up or "disintegration" of the crystal lattice, others, such as the work-hardening of hexagonal metals and crystal recovery, appear to leave the lattice undisturbed, and it is with these phenomena that this work is mainly concerned. The inadequacy of the classical theory of elasticity to account for these phenomena is briefly discussed and an attempt is made to describe them in terms of a geometrically perfect lattice whose elements are not identical. Each lattice-element is assumed to possess a characteristic property, its "state", in terms of which the internal energy, temperature and entropy are tentatively defined, and these assumptions are used as a basis for a theory of glide in metal crystals. The theory accounts qualitatively for the main glide phenomena such as the existence of a critical shear stress, work-hardening and recovery, and predicts a creep behavior closely resembling that observed in practice. The theory also predicts a dependence of critical shear stress of crystal size. The implications of the theory for future research are discussed and attention is particularly drawn to the importance of detailed microscopic examination of the surface of plastically deformed metal crystals. (Contractor's abstract)

PAR.01:001 - PAR.01:004

Palmer Physical Lab., Princeton, N. J. *see*
Princeton U. Palmer Physical Lab., N. J.

Palomar Observatory, Pasadena, Calif. *see* California
Inst. of Tech. Palomar Observatory, Pasadena.

PAR.01:001

Paris U. Lab. de Physique (France).

NON LOCAL SEPARABLE INTERACTION AND COLLISION MATRIX, by M. Gourdin and A. Martin. [1957] 28p. incl. diagrs. refs. (Technical note no. 2) (AFOSR-TN-57-491) (AF 61(514)1060) AD 136481
Unclassified

Also published in Nuovo Cimento, Series X, v. 6: 757-779, Oct. 1, 1957.

Solutions are sought for the problem of a 2-body (nucleon-nucleon) interaction in the S-state from the energy dependence of the experimental phase shift; a nonlocal separable central interaction is assumed. The interaction is given, in momentum space, by the solution of a Fredholm inhomogeneous integral equation of second kind. Explicit solutions were obtained when the energy dependence of the phase shift was exactly given by the shape-independent approximation. When the phase shift remained between 0 and π or between 0 and $-\pi$ in the whole range of variation of energy, results were similar to those obtained when a local interaction is assumed. If the physical system has no bound state, at most, one solution exists; with one bound state, there exists a one parameter set of solutions. If the energy dependence is not restricted, a solution can be obtained only if the end values, where δ goes through $n\pi$, satisfy certain inequalities. The solutions, then obtained, are mathematically correct but their physical interest is questionable. (Contractor's abstract)

PAR.01:002

Paris U. Lab. de Physique (France).

SPIN-ORBIT COUPLING AND TENSOR FORCES, by B. Jancovici. [1957] [29]p. incl. diagrs. table, refs. (Technical note no. 4) (AFOSR-TN-57-492) (AF 61(514)1060) AD 136482
Unclassified

Also published in Nuovo Cimento, Series X, v. 7: 290-307, Feb. 1, 1958.

The failure of tensor forces to account for the shell-model spin-orbit coupling was considered a strong indication of the existence of elementary mutual spin-orbit forces in the 2-body interaction. Calculations were made of the nonmodified reaction amplitude for cases in which the exclusion effects were both neglected and included. In the spirit of Brueckner's theory, computations were made of the many-particle terms of a perturbation series of the 2-body reaction amplitude. Up

to the second order in the interaction, only these terms occur if momentum is conserved in 2-body collisions. In the nuclear surface, terms could occur which do not conserve momentum; the question remains open as to whether such 3-particle terms are important in heavier nuclei.

PAR.01:003

Paris U. Lab. de Physique (France).

SPIN-ORBIT COUPLING AND TENSOR FORCES, by B. Jancovici. [1957] 3p. (Technical note no. 3) (AFOSR-TN-57-508) (AF 61(514)1060) AD 136495
Unclassified

Also published in Phys. Rev., v. 107: 631-632, July 15, 1957.

The magnitude of the nuclear spin-orbit coupling arising from tensor internucleon forces is calculated on the basis of the Brueckner many-body theory, and is found to have an algebraic value much smaller than that given by experiment.

PAR.01:004

Paris U. Lab. de Physique (France).

NUCLEON - NUCLEON SCATTERING AT HIGH ENERGY, by M. Gourdin. [1957] 33p. incl. diagrs. refs. (Technical note no. 7) (AFOSR-TN-57-683) (AF 61(514)1060) AD 136678; PB 133339
Unclassified

Also published in Nuovo Cimento, Series X, v. 7: 338-364, Feb. 1, 1958.

The nucleon-nucleon scattering and polarization experiments cannot be explained by a simple local potential. This method gives good results in the low energy domain. But between 0 and 300 mev, for example, it is well known that the Schrödinger equation is inadequate. It is necessary, at high energies, to use a completely covariant formulation for two body systems - the Bethe and Salpeter equation [Phys. Rev., v. 84: 350, 1232, 1951] - in order to take into account relativistic corrections. With an analytic continuation of the scattering amplitude for the imaginary values of relative time (or relative energy), we can generalize the method of partial waves to a four dimensional euclidian problem. It is shown that, in the simplified case of spinless particles (Klein-Gordon particles), the physical phase shifts corresponding to a given value of the orbital angular momentum are easily obtained. For the more realistic case of spin $\frac{1}{2}$ particles (Dirac particles) it is possible to calculate the differential cross section. Explicit solutions are obtained with an approximate method of resolution for the integral equations. Further, one can determine the value of the coupling constant that gives the correct experimental neutron-proton singlet scattering length, in the case of the "ladder approximation". The δ phase shift,

PAR.01:005-007; PAR.02:001

calculated for various values of the energy, exhibits a change of sign in the energy region of 140 mev. This result is in agreement with the experiments and the "hard core" theory of Levy [Phys. Rev., v. 81: 165, 1951; v. 86: 806, 1952; v. 88: 72, 725, 1952]. (Contractor's abstract)

PAR.01:005

Paris U. [Lab. de Physique] (France).

NUCLEON-ANTINUCLEON FORCES IN THE INTERMEDIATE COUPLING THEORY, by M. Lévy. [1958] 53p. incl. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-58-168) (Also bound with its AFOSR-TN-59-224; AD 211606) (AF 61(514)1060) AD 152195
Unclassified

Also published in Nuovo Cimento, Series X, v. 8: 92-134, Apr. 1, 1958.

A semi-phenomenological approach to meson theory is used in order to calculate the nucleon-antinucleon complex interaction responsible for the scattering and annihilation of antinucleons in hydrogen. It is assumed that the main part of the imaginary potential is due to processes involving virtual annihilation into an arbitrary number of mesons, all of them but one being emitted or absorbed in a p-state. An effective Hamiltonian is derived for such processes, from which a static interaction can be calculated with the nucleon and antinucleon being treated as fixed sources. The intermediate coupling theory of Tomonaga is extended to the two-body problem and applied first to the calculation of ordinary nuclear forces and of the real part of the nucleon-antinucleon interaction. The annihilation Hamiltonian is then treated approximately by the intermediate coupling method. The imaginary part of the potential is found to have a range of the order of $2 \text{ to } 3 \times 10^{-13} \text{ cm}$, beyond which it becomes a weakly oscillating function of the nucleon-antinucleon distance. The physical meaning of this result is discussed, as well as the effects which would tend to sharpen the definition of the emitted pions multiplicity. In particular, a method is proposed to investigate, in the framework of the intermediate coupling theory, the influence of the excited states of the nucleon-antinucleon system. (Contractor's abstract)

PAR.01:006

Paris U. Lab. de Physique (France).

EXACT DETERMINATION OF A PHENOMENOLOGICAL SEPARABLE INTERACTION, by M. Gourdin and A. Martin. [1958] 11p. incl. diagr. (Technical note no. 9) (AFOSR-TN-58-214) (Also bound with its AFOSR-TN-59-224; AD 211606) (AF 61(514)1060) AD 154115
Unclassified

Also published in Nuovo Cimento, Series X, v. 8: 699-707, June 1, 1958.

The determination of a phenomenological separable interaction fitting the energy dependence of a phase shift δ which is obtained from the experimental study of a collision problem can be reduced to the problem of finding the solution of an integral equation. The method of Muskhelishvili as applied by Ommnes has been used to solve this integral equation for the problem of one meson production by mesons. The interaction in momentum space is given by an expression containing only one integral. The results obtained in a previous paper (PAR.01:001) concerning the existence and multiplicity of the solutions are confirmed. The method is checked by an explicit calculation for the case when the phase shift is exactly given by the shape independent approximation.

PAR.01:007

Paris U. Lab. de Physique (France).

ON THE NUCLEON-ANTINUCLEON INTERACTIONS, by M. Gourdin, B. Jancovici, and L. Verlet. [1958] 16p. incl. tables. (Technical note no. 10) (AFOSR-TN-58-386) (Also bound with its AFOSR-TN-59-224; AD 211606) (AF 61(514)1060) AD 154293
Unclassified

Also published in Nuovo Cimento, Series X, v. 8: 485-496, May 1, 1958.

The nucleon-antinucleon cross-sections at 167 mev were computed with 2 complex potential well models. Yukawa shaped complex wells were first studied in Born approximation. A semi-theoretical potential was analyzed on the digital computer IBM 704. The real part of his potential is the Signell and Marshak potential, adapted to the nucleon-antinucleon problem, and the imaginary part, a Yukawa phenomenological well. In order to account for the experimental large total cross-section and small scattering cross-section, it appears necessary to choose a weak real potential and an imaginary potential having a range at least equal to the usual nuclear force range. The fixed source meson theory leads to a real potential, which is much too strong and does not predict an imaginary potential at all; this theory cannot account for the experimental results. (Contractor's abstract)

PAR.02:001

Paris U. Lab. de Physique (France).

EFFECTS OF PROTON CORRELATIONS ON THE SCATTERING OF HIGH-ENERGY ELECTRONS FROM NUCLEI, by L. I. Schiff. [1957] 16p. incl. refs. (Technical note no. 1) (AFOSR-TN-57-248) (Also bound with its AFOSR-TN-57-745; AD 136732) (AF 61(514)1061) AD 126546
Unclassified

PAR.02:002-004; PSU.01:007

Also published in Nuovo Cimento, Series X, v. 5: 1223-1237, May 1, 1957.

A study is made of the extent to which the correlations between protons in nuclear matter manifest themselves in the scattering of high-energy electrons from nuclei. The infinite-order Born is summed, so that dispersion effects that arise from excitation of virtual intermediate nuclear states are included to all orders. Use is made of a high-energy approximation developed earlier, and of the static or adiabatic approximation for the nuclear protons, and these are justified for incident electrons; their validity for nucleon scattering is also discussed. Expressions for the large-angle elastic and inelastic differential scattering cross sections are obtained in this way. It is then shown that correlation effects are difficult to identify so long as the final nuclear state is well-defined. On the other hand, if a sum over final states is carried out, the effects of short-range correlations between protons appear in a characteristic way in the summed differential cross section. These results are in qualitative agreement with those obtained earlier by others on the basis of the first and second Born approximation. (Contractor's abstract)

PAR.02:002

Paris U. Lab. de Physique (France).

THEORY OF HIGH-ENERGY POTENTIAL SCATTERING, by D. S. Saxon and L. I. Schiff. [1957] 16p. (Technical note no. 5) (AFOSR-TN-57-509) (Also bound with its AFOSR-TN-57-745; AD 136732) (AF 61(514)1061) AD 136494 Unclassified

Presented at meeting of the Amer. Phys. Soc., Boulder, Colo., Sept. 5-7, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 313, Sept. 5, 1957.

Also published in Nuovo Cimento, Series X, v. 6: 614-627, Sept. 1, 1957.

A new formulation for high-energy potential scattering, presented in a recent paper, is extended to provide explicit formulas for the scattering theory of the three-dimensional nonseparable Schrödinger equation. An integral equation is derived, for which a single iteration gives the scattering when the potential energy is not too large and is slowly-varying compared to a wavelength. The result agrees with those obtained earlier for small and for large scattering angles, but applies as well to intermediate angles and improves the earlier accuracy. Further iterations can provide greater accuracy as well as an error estimate for the first approximation. (Contractor's abstract)

PAR.02:003

Paris U. Lab. de Physique (France).

ON THE VALIDITY OF LEVINSON'S THEOREM FOR NON LOCAL INTERACTIONS, by A. Martin. [1957] 25p. Incl. diagrs. (Technical note no. 6) (AFOSR-TN-57-672) (Also bound with its AFOSR-TN-57-745; AD 136732) (AF 61(514)1061) AD 136661 Unclassified

Also published in Nuovo Cimento, Series X, v. 7: 607-627, Mar. 1, 1958.

An artificial boundary condition on the one-dimensional wave function is used to compare the number of eigenstates of a non-local Hamiltonian to the number of free eigenstates, provided that the free and interacting eigenstates tend to coincide at high energies. Orthogonality of the wave functions lead to the inequality of the phase shifts $\delta(0) - \delta(\infty) \geq \pi$, where ν is the number of bound states. For well behaved interactions the completeness of the eigenstates of non-local in Hamiltonian is demonstrated. It seems that the completeness of the eigenstates should lead to the inequality $\delta(0) - \delta(\infty) \leq \pi\nu$ and thus to the Levinson theorem $\delta(0) - \delta(\infty) = \pi\nu$. However the possible degeneracy of the wave function for positive energies must be taken into account. Levinson's theorem is modified to the following: $\delta(0) - \delta(\infty) = \pi$ (total number of eigenstates with vanishing asymptotic form). In this group there may be some states with positive energy. Application of these results to the Low equation is discussed.

PAR.02:004

Paris U. Lab. de Physique (France).

TECHNICAL REPORT OF RESEARCH PERFORMED BETWEEN OCT. 1, 1956 AND SEPT. 30, 1957 [57]p. Incl. diagrs. refs. (AFOSR-TN-57-745) (AF 61(514)1061) AD 136732 Unclassified

The general approach to high energy scattering has been extended by Schiff to treat scattering of 200 mev electrons from heavy nuclei. The scattering amplitude is found to depend on the proton coordinates and is therefore an operator on the nuclear wave functions. Proton correlations show up only in a sum of the differential cross-section over final states. Saxon and Schiff have extended the scattering amplitude expressions to include intermediate angles. A. Martin has investigated the Levinson theorem for non-local interactions and has shown that it is necessary to alter the theorem.

PSU.01:007

Pennsylvania State U. Dept. of Aeronautical Engineering, University Park.

HEAT TRANSFER AND SKIN FRICTION OF YAWED

PSU.01:008 - PSU.01:010

INFINITE WINGS WITH LARGE SUCTION, by H. G. Lew and J. B. Fanucci. Nov. 1956 [40]p. incl. diagrs. (Technical rept. no. 8) (AFOSR-TN-57-63) (AF 18(600)575) AD 120404
Unclassified

The flow over yawed infinite bodies with large suction is considered. Both the compressible and incompressible cases are treated. Some simple relations are determined for the skin friction coefficient and heat transfer coefficient variations with the pressure gradient, suction and sweep back parameters. In addition, a modified Reynolds analogy for the compressible case is obtained. In the compressible case, it is determined that the skin friction ratio varies linearly with the pressure gradient parameter β , the sweep back factor ω and the heat transfer parameter S_o up to and including the $(1/k^2)$ term where k is proportional to the magnitude of the suction velocity. Moreover, the Reynolds analogy $C_{f, eo}/N_u$ to this order of approximation varies linearly with the sweep back parameter ω for any given value of S_o , k , and β . For very large suction $C_{f, eo}/N_u$ is approximately 2. The effect of yaw for the stagnation point flow is to decrease the ratios of three to two dimensional coefficients of chordwise skin friction and heat transfer. The heat transfer coefficient h_t is decreased considerably by increasing sweep back. In the incompressible case, the spanwise skin friction coefficient is affected by the pressure gradient parameter β only if $(1/K^4)$ or higher order terms are considered, whereas the chordwise skin friction coefficient contains β linearly in the $(1/K^2)$ term. (Contractor's abstract)

PSU.01:008

Pennsylvania State U. Dept. of Aeronautical Engineering, University Park.

EFFECT OF YAW ON BOUNDARY LAYERS AT HIGH SPEEDS, by H. G. Lew and J. B. Fanucci. Nov. 1956 [52]p. incl. diagrs. tables, refs. (Technical rept. no. 9) (AFOSR-TN-57-221) (AF 18(600)575) AD 126519
Unclassified

The flow over yawed infinite wings in a compressible fluid have been considered with heat transfer at the surface. The main results are the wall shear, heat transfer coefficient, and the modified Reynolds analogy variations with sweepback. It is found that the modified Reynolds analogy $C_{f, eo}/N_u$ increases if the pressure gradient parameter $\beta > 0$ and decreases if $\beta < 0$ with increasing values of yaw and the heat transfer at the wall. The effects of yaw and heat transfer at the wall on the wall shear parameters and the heat transfer parameter are similar: for $\beta > 0$ these parameters are increased and for $\beta < 0$ (to $\beta = 0.1$) they are decreased if the yaw and heat transfer are increased at the wall. A

comparison of these results utilizing the expansions in S_o and ω , wherever possible, shows that for the usual range of these variables the present method is sufficient for most purposes. It is suggested that the ranges for these parameters be $0 < \omega < 0.5$ and $|S_o| < 0.4$ which encompasses a large practical range of yaw angle, free stream Mach number, and heat transfer at the wall as discussed in the text. The results for the stagnation point flow ($\beta = 1$) show that the heat transfer coefficient is decreased considerably by sweepback. For $\omega = 0$ the two-dimensional results are recovered and these compare very favorably with the more exact calculations of Cohen and Reshotko even to the extreme values of $S_o = \pm 1$. Thus, this method should be of considerable use for two-dimensional problems. (Contractor's abstract)

PSU.01:009

Pennsylvania State U. Dept. of Aeronautical Engineering, University Park.

BOUNDARY LAYER PROBLEMS, by H. G. Lew and J. B. Fanucci. Final rept. June 1957, 12p. (Rept. no. 12) (AFOSR-TR-57-38) (AF 18(600)575) AD 132394
Unclassified

Research was undertaken to make a critical study of the existing theoretical work on boundary-layer control and to study several problems of importance in the boundary-layer field. The majority of the problems which were considered were related to the behavior of the boundary layer under the influence of a small normal velocity at the boundary, i.e., porous suction or porous injection. Three-dimensional effects in the boundary layer were studied. The effect was determined of transverse curvature of flows over bodies of revolution in cases where the boundary-layer thickness may be of the same order of magnitude as the radius of the body. Some preliminary experimental work was done in determining the optimum suction distribution which may be used to eliminate the separation of the boundary layer. Abstracts of previous papers are also included.

PSU.01:010

Pennsylvania State U. [Dept. of Aeronautical Engineering] University Park.

SOME PRELIMINARY EXPERIMENTAL WORK ON THE FLOW OVER A CIRCULAR CYLINDER WITH POROUS SUCTION, by H. G. Lew, J. B. Fanucci, and R. D. Mathieu. May 1957, 7p. diagrs. (Rept. no. 10) (AF 18-600)575)
Unclassified

By the application of properly distributed suction, large savings in the suction quantity required to prevent or delay separation over a body can be achieved.

PSU.04:003; PSU.09:001;
PSU.10:001

Experiments are designed to show that the theoretical pressure distribution can be attained, except for regions near the rear stagnation point. The net decrease in drag coefficient, can be as much as 30% to 40% due to the large decrease in the pressure drag. Since the work was preliminary in nature, the circular cylinder was used in the tests. (Contractor's abstract)

PSU.04:003

Pennsylvania State U. Dept. of Chemistry, University Park.

[CHEMISTRY OF BORON COMPOUNDS] by T. Wartik, H. Bowkley and others. Final rept. [1957] 3p. (AF 18-(600)311; continued by AF 49(638)86) Unclassified

The studies carried out under this contract involve the determination of some of the thermodynamic properties of certain boron compounds and a study of the chemistry of certain boron-containing substances. The heat capacities of diboron tetrachloride were measured over the range from 13.43°K to 214.51°K. In addition, the heat of fusion, melting point, and vapor pressures over the region from 227.9°K to 272.94°K were determined. The Raman spectrum was determined for the liquid at $35 \pm 5^\circ\text{C}$, and the infrared spectrum was obtained for gas at room temperature. These results, in conjunction with infrared measurements in the low frequency region made at the Bureau of Standards, were used to calculate a potential barrier to internal rotation of the diboron tetrachloride molecule. The heat capacities of tetraborane (B_4H_{10}) were measured in the region from 13.37°K to 170.21°K. In addition, the heat of fusion, melting point, and vapor pressures in the region from 176.08°K to 216.08°K were determined. The reducing action of complex hydrides on carbon-sulfur compounds was studied, both in the presence and absence of solvent. In all cases, sym-trithiane (the trimer of thioformaldehyde) was the major carbon-containing product. In most cases, stoichiometries differing somewhat from integral ratios were encountered, and, on the basis of product distributions, reaction schemes involving parallel processes have been proposed. A relatively short time was devoted to a study of possible improvements in the discharge process for the preparation of diboron tetrachloride. In addition, measurements of the stability of diboron tetrachloride at room temperature were carried out. The production of boron-containing polymers through discharge-tube reactions between boron halides and carbon monoxide was investigated. With trichloroborane, a material of the composition $(\text{BCl}_3 \cdot 2\text{CO})_x$ resulted. This material acted as a thickening agent for water, and its chlorine content was not readily hydrolyzable.

PSU.09:001

Pennsylvania State U. Dept. of Chemistry, University Park.

SYNTHESIS OF SEQUESTERING AGENTS AND MEASUREMENT, by W. C. Fernellius. Dec. 1956, 62p. incl. diagrs. tables, refs. (AFOSR-TR-57-18) (AF 18(600)-446) AD 120456 Unclassified

A number of iminodiacetic acids and iminodipropionic acid were prepared. Two of these are compounds not elsewhere described: t-amyliminodiacetic acid and 3-methyl-3-nitrobutyliminodiacetic acid. The reaction of α -chloropropionic acid with amines failed to give diacids, only monoacids. Such acids of 2-methoxyethylamine, 3-hydroxypropylamine and 3-methoxypropylamine were prepared. The experimental results together with those in the literature are summarized and discussed under the topics: synthesis of acids, dissociation constants, formation constants, and isolation of metal derivatives. An extensive bibliography of foreign and domestic references is included covering a time period from 1869-1956.

PSU.10:001

Pennsylvania State U. Dept. of Chemistry, University Park.

DISCHARGE-INDUCED REACTIONS OF BORON HALIDES WITH SOME NONMETALLIC OXIDES, by R. M. Rosenberg and T. Wartik. [1958] 153p. incl. diagrs. tables, refs. (AFOSR-TN-58-979) (AF 49(638)86; continuation of AF 18(600)311) AD 206769 Unclassified

An investigation was undertaken of the discharge chemistry of B compounds in order to understand the behavior of these substances and to develop new or improved synthetic methods. The behavior of the trihalides of B (except the triiodide) and of diboron tetrachloride, separately and in the presence of nonmetallic oxides, was investigated in an ozonizer-type discharge. Of the 2-component systems, trichloroborane (BCl_3)-CO was examined most extensively. The major discharge product from the reaction of $2\text{BCl}_3 + \text{CO} \rightarrow \text{B}_2\text{Cl}_4 + \text{COCl}_2$ was a nonvolatile film deposited on the discharge tube walls. The reaction of BCl_3 and CO_2 produced a solid which contained no C and which was deposited on the tube walls. Discharge studies of the single components, CO, CO_2 , SO_2 , and N, were used to establish the behavior of these pure substances in the type of apparatus used in these investigations. The systems BF_3 -CO and BBr_3 -CO were also studied. The order of stability with respect to reaction in the discharge was $\text{BF}_3 > \text{BCl}_3 > \text{BBr}_3$. The reaction of C_3O_2 and BCl_3 produced a

PSU.05:005 - PSU.05:008

mixture of polymerized C_3O_2 and a $C_3O_2-BCl_3$ adduct, the latter bearing little physical or chemical resemblance to the $CO-BCl_3$ film. A new method was developed which permitted the determination of B, Cl, and C from a single sample of a compound containing these elements. (ASTIA abstract)

PSU.05:005

Pennsylvania State U. Field Emission Lab., University Park.

FIELD DESORPTION BY ALTERNATING FIELDS. AN IMPROVED TECHNIQUE FOR FIELD EMISSION MICROSCOPY, by E. C. Cooper and E. W. Müller. [1958] [4]p. incl. illus. diagrs. refs. (AFOSR-TN-57-738) (AF 18(600)672) AD 202329 Unclassified

Also published in Rev. Scient. Instruments, v. 29: 309-312, Apr. 1958.

The inclusion of field desorption in field emission microscopy yields additional information on adsorption systems and easily produces clean surfaces of metal tips without the application of heat. An alternating field technique is described using a dc-biased ac power supply for providing the desorption field during the positive portion of the cycle and allowing the observation of the field electron image during the negative portion. Ion and electron current during one cycle are calculated for a tungsten tip. Patterns from clean nickel, iron, and copper are shown. (Contractor's abstract)

PSU.05:006

Pennsylvania State U. Field Emission Lab., University Park.

PSEUDOSPIRALS, IMPERFECT STRUCTURES AND CRYSTAL HABIT PRODUCED BY FIELD EVAPORATION OF METAL CRYSTALS, by E. W. Müller. Oct. 18, 1957, rev. Feb. 24, 1958 [11]p. incl. illus. refs. (Technical rept. no. 7) (AFOSR-TN-57-739) (AF 18(600)672) AD 211081 Unclassified

Also published in Acta Metallurgica, v. 6: 620-630, Sept. 1958.

Spiral-like structures are frequently observed when the tip of a field emission microscope is subjected to field evaporation at elevated temperatures. Close inspection of tips of various metals with the field ion microscope reveals that these structures are pseudo spirals, appearing as a result of eccentric bunching of complete low index net planes, without requiring the presence of a screw dislocation. The extremely large stress of the field causes various dislocations to move towards and

to pile up at the surface, where they can be seen in the ion image. A picture is shown of the atomic arrangement at a low angle twin boundary in a tungsten crystal parallel to the [100]-zone. Field evaporation carried out at temperatures below the range where imperfections can move to the surface may yield perfect surfaces. Their habit is characterized by a rounded-off shape, with the radius curvature varying in the same sense as the work function of the particular crystallographic region. The field strength for evaporation of tungsten at practically zero temperature is measured to be

1×10^9 v/cm on the 111 plane and 8×10^8 v/cm on the 011 plane, in agreement with the theory. Crystal surfaces, as obtained by low temperature evaporation at slightly lower field strengths, are also shown for platinum, iridium and rhenium. (Contractor's abstract)

PSU.05:007

Pennsylvania State U. [Field Emission Lab.] University Park.

AN ATTEMPT TO DETECT POLARIZATION OF FIELD EMITTED ELECTRONS, by W. T. Pimbley and E. W. Müller. [1957] [1]p. (AF 18(600)672) Unclassified

Presented at the Field Emission Symposium, Penn. State U., University Park, June 27-29, 1957.

Under certain conditions, it is conceivable that the electrons emitted from a field emission tip are polarized. An experiment designed to detect such a polarization is described. Mott relativistic scattering of electrons from heavy nuclei is used to detect the polarization. The tube has a provision for electrostatically shifting the image of the emitter surface in two coordinates over a probe hole in the screen, so that, for example, each corner of a molecule quadruplet can be examined separately. The electron beam is then accelerated to above 100 kv and scattered from a gold foil. The distribution of the scattered electrons is recorded photographically with the help of a cylindrical fluorescent screen. Results are expected as soon as some difficulties from spurious emission between the accelerator electrodes are overcome. (Contractor's abstract)

PSU.05:008

Pennsylvania State U. [Field Emission Lab.] University Park.

NEW TECHNIQUE FOR FIELD EMISSION MICROSCOPY OF NON-REFRACTORY METALS (Abstract), by E. C. Cooper and E. W. Müller. [1957] [1]p. (AF 18(600)672) Unclassified

Presented at the Field Emission Symposium, Penn. State U., University Park, June 27-29, 1957.

PSU.05:009 - PSU.05:011

Field desorption is an effective means of perfectly cleaning the surface of a field emitter. If the field emission microscope is operated with ac, it is possible to observe the progress of field desorption by increasing the positive half wave independently from the image forming negative half wave. A power supply for these requirements is described. The method allows the study of the dynamics of field desorption of surface films. The binding force to the substrate can be gradually reduced to zero, while the mutual attraction of the adsorbed particles remains essentially unchanged. As an example the desorption of hydrogen and nitrogen from iridium and the effect of the cohesive forces within the film is shown. The production of perfectly clean surfaces by controlled field evaporation of several surface layers of the tip metal itself makes it possible to easily obtain patterns from soft metals like nickel, iron, and copper as well as high melting metals. The patterns obtained by field evaporation are slightly different from the common annealed form because of perfect development of high index planes and a local field enhancement factor specific to the various crystal planes.

PSU.05:009

Pennsylvania State U. [Field Emission Lab.] University Park.

RECENT WORK IN FIELD ION MICROSCOPY (Abstract), by E. W. Müller. [1957] [1]p. (AF 18(600)672) Unclassified

Presented at the Field Emission Symposium, Penn. State U., University Park, June 27-29, 1957.

An experimental study of the resolution under various conditions shows that by far the best results are obtained with helium ions and liquid hydrogen cooling. Rows of adjacent atoms with 2.74Å separation are resolved on the 111-zone lines of tungsten. For demonstration purposes the helium ion microscope can be cooled by liquid nitrogen or better solid nitrogen, and still resolves the single lattice steps and individual atoms on high index planes. With hydrogen ions one needs only half the field strength, so that metals as soft as copper can be observed. However, the resolution at 21°K is not better than 4.5Å. There seems to be only a slight improvement when the temperature is lowered to 13°K. Deuterium ions give better resolution than hydrogen ions, but difficulties arising from adsorption are inconvenient. A number of pictures of tungsten and rhenium surfaces with various degrees of disorder, from cold worked and otherwise disturbed structures over field produced pseudo spirals to high annealed and field desorbed perfect surfaces are discussed. Work with the helium ion microscope is facilitated by a new design with easily replaceable tips.

PSU.05:010

Pennsylvania State U. [Field Emission Lab.] University Park.

STUDY OF MOLECULE PATTERNS IN THE FIELD EMISSION MICROSCOPE (Abstract), by A. J. Melmed and E. W. Müller. [1957] [1]p. (AF 18(600)672) Unclassified

Presented at the Field Emission Symposium, Penn. State U., University Park, June 27-29, 1957.

Since the nature of molecule patterns is still not understood, a series of experiments was carried out to find new facts. The best substance, experimentally, was phthalocyanine. Cooling the tip with liquid nitrogen or liquid hydrogen gives extremely clear and stable patterns, and almost always quadruplets on clean tungsten at low coverages. There is a distinct preference of adsorption sites with respect to the crystal planes of the substrate, and perfect alignment of the molecule patterns with the lattice direction. Appearance and orientation depend upon lattice constant and crystal structure of the substrate as investigated with W, Ta, Re, and Ir. The effect of high field strengths on the stability (persistence) was observed as a preparation for depicting the molecules with the field ion microscope. Superimposed electron and ion images of phthalocyanine were observed using an alternating current method. Some hydrogen ion images were photographed showing small doublets where the electron images were large doublets.

PSU.05:011

Pennsylvania State U. [Field Emission Lab.] University Park.

ATOMS VISUALIZED, by E. W. Müller. [1957] [10]p. incl. illus. diagrs. [AF 18(600)672] Unclassified

Published in Scient. Amer., v. 196: 113-122, June 1957.

This paper shows that the field ion microscope makes pictures of atoms in a metal crystal by accelerating positive ions from a fine needle of the metal to a fluorescent screen. An actual photograph is shown of individual atoms — tungsten atoms on a needle tip a thousand times finer than the tip of an ordinary pin. The photograph was taken by an instrument (the field ion microscope), which is an improved version of the field emission microscope that was introduced by the author in 1936. A description of the field emission microscope and results of its usage are presented. The principal features of the field ion microscope (a modification of the field emission microscope) are discussed and depicted diagrammatically. The new techniques employed in observing atoms have permitted one to study metals at the atomic level with a precision never before possible. So far, good images have been obtained only of

PSU.05:012 - PSU.05:015

metals such as tungsten, rhenium, tantalum and molybdenum and some of the thin highly refractory alloys—carbides and alloys. The technique at present is limited to the very hard metals.

PSU.05:012

Pennsylvania State U. [Field Emission Lab.] University Park.

[OPERATING CONDITIONS OF THE LOW TEMPERATURE-FIELD ION MICROSCOPE] Betriebsbedingungen des Tieftemperatur-Feidionenmikroskopes, by E. W. Mütler. [1957] [7]p. incl. illus. diagr. [AF 18(600)672] Unclassified

Published in Ann. Physik, v. 20: 315-321, July 15, 1957.

Two methods are described for the measurement of the longitudinal and transverse nuclear paramagnetic relaxation time. It is shown that the technique known as the Hahn spin-echo method allows measurement of the longitudinal relaxation time over a practically unlimited region after long times, while for the measurement of the transversal relaxation time the self diffusion sets an upper limit. The influence of the self-diffusion is eliminated through the use of impulses of definite breadth and intensity by Carr-Purcell's method, by means of which arbitrarily long times become measurable. In contrast to the Hahn method the measurement is strongly dependent upon small maladjustments, which makes the measurement of relaxation times less accurate.

PSU.05:013

Pennsylvania State U. Field Emission Lab., University Park.

STUDY OF PHTHALOCYANINE AND SOME OTHER PLANAR MOLECULES IN THE FIELD EMISSION MICROSCOPE, by A. J. Meimed. July 1958, 68p. incl. illus. diagrs. table, refs. (AFOSR-TN-58-646) (AF 18(600)672) AD 162178 Unclassified

Also published in Jour. Chem. Phys., v. 29: 1037-1041, Nov. 1958. (Title varies)

An improved technique for studying organic substances in the field emission microscope is described, in which the field emitter is kept at a low temperature during observations. Field emission patterns of organic molecules such as phthalocyanine or flavanthrene show improved stability when the tip temperature is lowered. No prior contamination or buildup is necessary for the production of typical quadruplet or doublet patterns. Upon heating or ion bombardment the molecule patterns may disappear in several distinct steps of size and intensity. On the average 13 phthalocyanine or 2 flavanthrene molecules must strike the tip to produce one pattern. These observations suggest that the substances

studied here evaporate and arrive at the tip as polymerized units consisting of two to six molecules. Field desorption and hydrogen ion images of Cu-phthalocyanine on tungsten and platinum are investigated. Finally, a mechanism for molecular image formation is proposed. (Contractor's abstract)

PSU.05:014

Pennsylvania State U. Field Emission Lab., University Park.

THEORETICAL AND EXPERIMENTAL TOTAL-ENERGY DISTRIBUTION OF FIELD EMITTED ELECTRONS, by R. D. Young. Dec. 1958, 44p. incl. diagrs. tables. (Technical rept. no. 9) (AFOSR-TN-58-1136) (AF 18(600)672) AD 208085 Unclassified

Also published in Phys. Rev., v. 113: 110-114, Jan. 1, 1959.

The energy distribution measurement was employed to study the electronic band structure in metals and semiconductors. When the energy analyzer was improved to carry out this study, the measured energy distribution was much narrower than predicted by the existing normal-energy distribution theory. Further investigation revealed that the retarding potential energy analyzer employed measures the total electron energy rather than the energy associated with the component of velocity normal to the surface. The Fowler-Nordheim equation was derived in a new way to preserve the distribution in total energy of field emitted electrons. A similar derivation was made for thermionic emission. A striking mirror image symmetry was found between the normal-energy thermionic emission and the total-energy field emission energy distributions. A similar symmetry was noted between the total-energy thermionic and normal-energy field emission energy distributions. Further analysis indicated that the widths of the energy distributions are the same. This means that field emission and thermionic emission are on an equal footing in cases where energy distribution contributes to vacuum tube noise or to chromatic aberration in electron optics. Energy distribution measurements at liquid hydrogen, liquid nitrogen and room temperature were found to agree with the new theory. (ASTIA abstract)

PSU.05:015

Pennsylvania State U. [Field Emission Lab.] University Park.

SURFACE STRUCTURE OF FIELD EVAPORATED METALLIC CRYSTALS (Abstract), by E. W. Müller and J. F. Muison. [1958] [1]p. [AF 18(600)672] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

PSU.05:016, 017; PSU.06:007, 008

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 69, Jan. 29, 1958.

Low-temperature field evaporation of refractory metal tips produces the cleanest surfaces of atomically perfect smoothness. Unlike the heat of vaporization of neutral atoms, the work to remove ions from a surface depends upon the crystallographic orientation because of the variation of the thermionic work function. The habit of the end form of a field evaporating metal crystal is characterized by a rounded off shape with the radius of curvature varying in the same sense as the work function of the considered region. At practically zero temperature, the actual field strength for evaporation of tungsten ions from the 111 plane is measured to be 1 billion v/cm, and for the 110 plane, 800 million v/cm, in agreement with the image force theory. High resolution ion microscope pictures of field evaporated surfaces of tungsten, rhenium, iridium, platinum, and platinum-rhodium alloy with either perfect or imperfect structures are presented. The controlled evaporation at 21°K of individual atoms and single net planes of a platinum crystal will be shown in a short 16-mm movie film.

PSU.05:016

Pennsylvania State U. [Field Emission Lab.] University Park.

EXTREME STRESS CONDITIONS AT THE TIP CRYSTAL OF THE FIELD ION MICROSCOPE (Abstract), by E. W. Müller. [1958] [1]p. [AF 18(600)672]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 265, June 13, 1958.

The tip crystal in a field ion microscope is under a radial stress of 10^{11} dynes/cm² or more. If dislocations are absent, this stress does not exceed the strength of W, Re, Mo, Ta, Ir, Pt, Zr, Si, and C and perhaps a few other metals. The limitation for the observation in the FIM is set by field evaporation of individual ionized surface atoms, the rate of evaporation becoming rather fast towards the end of the foregoing list when He ions are used. Since the radial stress can also be considered as a negative pressure of 10^5 atm, regional phase transitions to a lower density lattice might occur. If dislocations are introduced, the gradient of stress towards the shank may cause slip, since in general the slip planes are inclined to the tip axis. This is not true for rhenium, where the basal plane as the only slip plane was always found to be parallel to the tip axis. Motion of dislocations and slip of parts of the crystal can be

observed continuously in high resolution while the stress is made alternating by superimposing an ac component to the dc field. This is a novel method for studying fatigue.

PSU.05:017

Pennsylvania State U. [Field Emission Lab.] University Park.

FIELD ION MICROSCOPE IMAGES OF PLATINUM SURFACES (Abstract), by E. W. Müller. [1958] [1]p. [AF 18(600)672]
Unclassified

Presented at meeting of the Electron Microscope Soc. Amer., Santa Monica, Calif., Aug. 7-9, 1958.

Published in Jour. Appl. Phys., v. 29: 1625, Nov. 1958.

Although platinum is not a metal with a very high melting, the rate of field evaporation of Pt ions is relatively low because of its high ionization potential. It is therefore possible to obtain steady high-resolution helium ion images of perfect crystals and of surfaces with dislocations.

PSU.06:007

Pennsylvania State U. Field Emission Lab., University Park.

STUDY OF ATOMIC STRUCTURE OF METAL SURFACES IN THE FIELD ION MICROSCOPE, by E. W. Müller. Mar. 1957, 6p. incl. illus. diagrs. refs. (Technical rept. no. 3) (AFOSR-TN-57-120) (AF 18(600)673) AD 120474
Unclassified

Also published in Jour. Appl. Phys., v. 28: 1-6, Jan. 1957.

Details of the image formation in the low temperature field ion microscope are discussed. The hopping height of the rebounding gas atom, which depends on the atom's polarizability, the tip temperature, tip radius, and field, is significant for the resolution. Photographs of tungsten and rhenium surfaces with the atomic lattice resolved and in different states of disorder are presented. A color printing technique, which permits finding quickly a few displaced atoms among the many thousand that are visible, is described.

PSU.07:008

Pennsylvania State U. X-Ray and Crystal [Analysis] Lab., University Park.

THE CRYSTAL STRUCTURE OF PYRIDINIUM REINECKATE, by Y. Takeuchi and R. Pepinsky. [1957] iv. incl. illus. diagrs. tables. (Sponsored jointly by

PSU.07:009 - PSU.07:011

Air Force Office of Scientific Research under AF 18-(600)1556 and Office of Naval Research under N6onr-26916) Unclassified

Published in Zeitschr. Krist., v. 109: 29-41, July 1957.

Crystals of pyridinium reineckate, $C_5H_5NH \cdot [Cr(NCS)_4(NH_3)_2]$, are monoclinic with space group A2/a. The unit cell has dimensions $a = 15.52 \text{ \AA}$; $b = 7.64 \text{ \AA}$; $c = 14.64 \text{ \AA}$; $\beta = 102.4^\circ$, and contains four formula units. The structure was determined by the use of two-dimensional Fourier syntheses. The chromium atom of the reineckate radical is at a center of symmetry. The pyridinium ion, which lies on the two-fold axis, is surrounded by twelve sulfur atoms. Four of the sulfur atoms coordinate to the pyridinium nitrogen, with two distances of 3.36 \AA and two of 3.80 \AA . Mean values of bond lengths in the reineckate ion are Cr - N, 1.95 \AA ; N - C, 1.15 \AA ; C - S, 1.76 \AA . Distances within the pyridinium ion are C - C, 1.40 \AA ; C - N, 1.35 \AA . The x-ray crystallography of a few other organic-base reineckates is reported. (Contractor's abstract)

PSU.07:009

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

X-RAY AND THERMAL STUDIES OF ORDER-DISORDER PHASE TRANSITIONS IN SOME COMPLEX-ION SALTS (Abstract), by N. [R.] Stemple, Y. Okaya and others. [Nov. 1957] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(800)1556 and Signal Corps Engineering Labs. under DA 36-039-sc-72385) Unclassified

Presented at Pittsburgh Diffraction Conference, Pa., Nov. 6-8, 1957.

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 59, Jan. 29, 1958.

New order-disorder transitions have been found in the cubic crystals of $[Co(NH_3)_6](ClO_4)_3$, $[Co(NH_3)_6](BF_4)_3$, $[Co(NH_3)_6]SO_4Br$, and $[Co(NH_3)_5H_2O](ClO_4)_3$. In these, the large complex ion dominates the packing of the structures, and the smaller ions have some freedom in position and orientation. The transitions have been examined optically, by x-rays, and thermally. The ordered phase has a superstructure lattice with cell constant twice that of the disordered phase. Remaining short-range order in the disordered phase is studied by means of diffuse scattering in stationary-crystal photographs

taken with filtered $CuK\alpha$ radiation. The transitions are discussed thermodynamically. Similar studies are reported for other $[Co(NH_3)_6]^{+++}$ salts.

PSU.07:010

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

X-RAY ANALYSES OF SOME COMPLEX-ION STRUCTURES, by Y. Okaya, R. Pepinsky and others. [1957] 14p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(800)1556, National Institutes of Health, and Office of Naval Research) Unclassified

Published in Acta Crystallographica, v. 10: 798-801, Dec. 10, 1957.

The crystal structures or symmetries of a variety of complex ion compounds are presented. The substances include: (1) Cr and Fe hexaurea complexes, (2) sodium cobaltinitrite and sodium nitroprusside dihydrate, (3) hexamminecobalt (III) salts, (4) the cis and trans dinitrobisethylenediamminecobalt (III) nitrate, (5) $K_3Co(CN)_6$ and related salts, (6) cupric and nickelous glycinate, (7) tetrahalogeno divalent-metal alkyl amines, (8) d-tris ethylenediamine cobalt (III)-halide-d-tartrate- $5H_2O$, and (9) "engineered" crystals. A table listing 20 engineered crystals is given and it is concluded that the packing in these crystals is controlled chiefly by the large complex ions and that the organic ions fill in spaces between these ions. Furthermore by properly matching the ionic sizes and shapes, charges, dipolar character, solubilities, etc. it is possible to exert a good deal of control over the arrangement of the organic ions within the crystal.

PSU.07:011

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

THERMAL AND X-RAY STUDIES OF ORDER-DISORDER PHASE TRANSITIONS IN SOME CUBIC HEXAMMINE-COBALT (III) SALTS, by N. R. Stemple. June 1957 [48]p. incl. illus. diagrs. refs. (Technical rept. no. 4) (AFOSR-TN-58-330) (AF 18(600)1556) AD 154234 Unclassified

New order-disorder transitions were found in the cubic crystals of the $[Co(NH_3)_6]^{+++}$ ion and the ions ClO_4 , BF_4 , and SO_4Br for which thermodynamic properties are discussed. These transitions are similar to those found in the "engineered" crystals of Pepinsky, and in AgI and Ag_2HgI_4 , where large ions also dominate the packings

PSU.07:012; PSU.08:010-012

of the structure and smaller ions have some freedom in their positions. The transitions were studied both by x-ray and thermal measurements. It is established that the ordered phase has a superstructured lattice with the cell constant twice that of the disordered phase. Remaining short-range order in the disordered phase is also studied by means of the maxima in the diffuse areas of Laue photographs taken with filtered $\text{CoK}\alpha$ radiation. The behavior of these maxima was found to be similar to that in binary alloys. (Contractor's abstract, modified)

PSU.07:012

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

SCHEME FOR MICROCHEMICAL IDENTIFICATION OF ALKALOIDS, PARTS I AND II, by F. Amelink, tr. by M. L. Willard, ed. by R. Pepinsky and J. Lombard. Feb. 1, 1957, 2v. incl. diagrs. tables, refs. (Technical rept. no. 3) (AFOSR-TN-58-331) (AF 18(600)1556) AD 154235 Unclassified

This work deals with the problem of identification of alkaloids and related synthetic medicinals by means of microchemical reactions. The presentation of a simple scheme for identification is a major contribution to the subject area. The description of reagents and 8 general reactions including methods of crystallization precedes the treatment of 95 alkaloids. A few applications to plant materials are found at the end of the book. The translation emphasizes the aspects of (1) x-ray and crystal-chemical investigations of salts of organic ions and complex ions and (2) application of the principle of "engineered crystals" for preparation of crystalline organic compounds particularly suited to x-ray structure analysis. An extensive bibliography is included.

PSU.08:010

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

A BRIDGE FOR ACCURATE MEASUREMENT OF FERROELECTRIC HYSTERESIS, by H. Diamant, K. Drenck, and R. Pepinsky. [1957] [23]p. incl. illus. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35] and Signal Corps Engineering Labs. under [DA 36-039-sc-63233]) Unclassified

Published in Rev. Scient. Instruments, v. 28: 30-33, Jan. 1957.

A new instrument was designed for the undistorted display of ferroelectric hysteresis loops even in the presence of relatively high conductivity. The electrical characteristics of a sample are determined directly from dial settings and meter readings. The basic circuit

of the bridge may be described as two parallel Sawyer and Tower circuits, one containing the sample and the other containing resistors and capacitors for the compensation of conductivity and dielectric constant at saturation. The compensated hysteresis loop is displayed on an oscilloscope with the aid of a calibrated differential amplifier. The spontaneous polarization and the applied voltage, as well as the coercive field, are read on an electronic peak-voltmeter. An important feature of the bridge is that measurements are independent of the frequency and waveform of the applied voltage. (Contractor's abstract)

PSU.08:011

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

NEUTRON DIFFRACTION STUDY OF ORTHORHOMBIC BaTiO_3 , by G. Shirane, H. Danner, and R. Pepinsky.

[1957] 20p. incl. diagrs. tables, refs. (In cooperation with Brookhaven National Lab., Upton, N. Y.) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs. under DA 36-039-sc-63233, Atomic Energy Commission under AT (30-1)1516, and Office of Naval Research under N6onr-26916) Unclassified

Presented at Fourteenth Pittsburgh Diffraction Conf., Oct. 31-Nov. 2, 1956, Paper no. 44.

Published in Phys. Rev., v. 105: 856-860, Feb. 1, 1957.

The atomic positions of ferroelectric BaTiO_3 in its orthorhombic phase have been determined by a single crystal neutron diffraction analysis. Pillar-shaped crystals with their major axes along the cubic [110] direction were maintained as single domains by the application of an electric field. The structure deduced can be viewed as a framework of slightly distorted oxygen octahedra, in which the central Ti ions are displaced towards one of the octahedron edges (polar axis) by 0.13A. The Ba ions are also shifted in the same direction but by smaller amount of 0.07A. A comparison of this structure with that of the tetragonal phase suggests the essential role of Ti in the ferroelectricity of this crystal as treated by Slater. (Contractor's abstract)

PSU.08:012

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

X-RAY AND NEUTRON STRUCTURE ANALYSIS OF FERROELECTRIC RHOMBOHEDRAL $\text{Pb}(\text{Zr}_{0.75}\text{Ti}_{0.25})\text{O}_3$ AT ROOM TEMPERATURE (Abstract), by F. Unterleitner, G. Shirane and others. [1957] [1]p.

PSU.08:013 - PSU.08:015

(Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc. Series II, v. 2: 127, Mar. 21, 1957.

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Also published in Bull. Amer. Phys. Soc., Series II, v. 2: 220, Apr. 25, 1957.

The solid solution $\text{Pb}(\text{Zr}_{0.75}\text{Ti}_{0.25})\text{O}_3$ is ferroelectric and rhombohedral at room temperature, and is cubic (perovskite) at higher temperature. No ferroelectric rhombohedral structure had been completely established heretofore. A powder x-ray analysis established heavy atom positions in this rhombohedral phase; oxygen positions were determined from a neutron powder pattern. The space group is $R\bar{3}m$, with cell constants $a = 4.11\text{\AA}$, $c = 89^\circ 41'$. Atomic coordinates are: Pb at (δ, δ, δ) , with $\delta = 0.575$; (Zr, Ti) at (ξ, ξ, ξ) , with $\xi = 0.040$; O at $(\gamma, 0, 0)$, $(0, \gamma, 0)$, $(0, 0, \gamma)$ with $\gamma = 0.520$. The oxygen octahedra surrounding the (Zr, Ti) atoms are only slightly distorted, and atomic displacements are of the same order as in tetragonal ferroelectric PbTiO_3 .

PSU.08:013

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

CRYSTAL-CHEMICAL MECHANISMS IN FERROELECTRICS AND ANTIFERROELECTRICS, by R. Pepinsky. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs under DA 36-039-sc-63233, Atomic Energy Commission under AT(30-1)1516, and Brookhaven National Lab.) Unclassified

Presented at meeting of the Phys. and Inorg. Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Published in 131st meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 29-R-30-R.

At present eleven classes of ferro- or antiferroelectric crystals are well established. The progress made in the understanding of the basic properties and transition mechanisms is given for each of the eleven classes as well as statements concerning needed study.

PSU.08:014

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

ON SOME OLD, NEW AND YET-UNDISCOVERED FERROELECTRICS AND OTHER INTERESTING DIELECTRICS (Abstract), by R. Pepinsky. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission) Unclassified

Presented at meeting of Special Technical Conf. on Solid-State Dielectric and Magnetic Devices, (AIEE and IRE), Catholic U. of America, Washington, D. C., Apr. 22-23, 1957.

Eleven crystal-chemical classes of ferroelectrics and antiferroelectrics are presently known. A very brief account is given of what is known of the structures and the structural mechanisms of transitions in these crystals. Directions of research for new ferroelectrics and antiferroelectrics are outlined. These include some crystal-chemical criteria and their application; reports of some old and some new crystal transitions; likely materials to be examined; some useful experimental techniques; and reasons why the search for new ferroelectrics must continue. Some other interesting dielectrics are discussed.

PSU.08:015

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

FERROELECTRIC BEHAVIOR OF $\text{NH}_4\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ (Abstract), by F. Jona, K. Vedam and others. [1957] [1]p. (AF 18(603)35) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

A re-investigation of the dielectric anomaly which occurs in ammonium iron alum at low temperatures has been carried out. The dielectric constant is about 6 at room temperature, and rises to a sharp peak, of approximately 60, at -185°C . A large ac field applied along the cubic [100] direction causes the appearance of double hysteresis loops above and close to the transition point, indicative of a first-order ferroelectric transition, as observed in the case of BaTiO_3 . In a 60 cps electric field of 20 kv/cm, the double loops can be observed within a range of about 2°C above the transition temperature. Ferroelectric loops appear at and below the Curie point, but can only be observed in a temperature range 1 to 2° below the transition. The spontaneous polarization P_s is of the order of 0.3 microcoulomb/cm², and the coercive field about 20 kv/cm. At about 2° below the Curie point, the hysteresis loop collapses suddenly to a narrow

PSU.08:016 - PSU.08:018

ellipse. This indicates that the motion of the domain walls is hindered and the coercive field is far larger than the breakdown field. The behavior of the crystal under a strong ac field applied along the cubic [111] direction is such that the crystal acts as if the transition were of the second order.

PSU.08:016

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

FERROELECTRICITY AND STRUCTURE OF TRI-GLYCINE FLUOBERYLLATE AND ISOMORPHS (Abstract), by R. Pepinsky, T. Okaya, and F. Jona. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs.) **Unclassified**

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 220, Apr. 25, 1957.

Tri-glycine sulfate and selenate have previously been observed to be ferroelectric and now tri-glycine fluoberyllate which is isomorphous has also been observed to be ferroelectric. The crystal is piezoelectric below the Curie temperature $T_c = 75^\circ\text{C}$. Other data reported are: coercive field is 5 kv/cm; the spontaneous polarization is $P_s = 3.2 \times 10^{-6}$ cb/cm²; space group is found to be $P2_1$ below the Curie temperature and $P2_1/m$ above; and the unit cell dimensions and angles are similar for all three substances. The x-ray intensities from the sulfate are essentially unaltered above and below T_c and the fluoberyllate shows differences, but the selenate shows stacking disorder along a , immediately above T_c . The crystal structure above T_c is such that one glycine and the inorganic anion are on a mirror plane and two glycines are mirrored across the plane. H-bonds are found to be responsible for maintaining the structure. The mirror symmetry, chiefly of H's, disappears below T_c , producing polarization along b . Optically-active amino acids only, and acid-unstable inorganic anions, cannot form isomorphous crystals.

PSU.08:017

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

THERMAL, DIELECTRIC AND OPTICAL STUDIES OF SOME NEW FERROELECTRICS, by D. R. P. Eastman. May 13, 1957, 43p. incl. diagrs. refs. (Sponsored jointly

by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission) **Unclassified**

The dielectric, crystallographic, optical, and thermal properties of $(\text{NH}_4)_2\text{Cd}_2(\text{SO}_4)_3$ were measured in order to establish the thermodynamic character of the ferroelectric transition and to estimate the order of magnitude of the entropy change at the Curie point. At room temperature the crystal is cubic with $a = 10.360\text{\AA}$ and apparently belongs to the langbeinite class. The space group is $P2_13$ and there are 4 formula units per cell. The Curie point is at $95 \pm 2^\circ\text{K}$ and the spontaneous polarization along the [100] direction is $0.50 \mu\text{c}/\text{cm}^2$ near the transition temperature. The direction of the polar axis in the ferroelectric phase is along the [100] direction. Saturated ferroelectric loops can only be observed in a temperature range of 4 to 5 degrees below the Curie temperature. The coercive field at 91°K in the [100] direction is 9.5 kv/cm and increases rapidly for decreasing temperatures until at 90°K it exceeds the breakdown field. The heat of transition at the Curie point is the order of 10^3 cal/mole. Measurements of the thermal expansion indicate a contraction along the original cube axis as the point is passed from above. The symmetry of the low-temperature phase is very probably monoclinic.

PSU.08:018

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

X-RAY, OPTICAL, AND DIELECTRIC STUDIES OF THE LOW-TEMPERATURE TRANSITION IN SODIUM NIOBATE, by J. F. Johns. May 13, 1957 [30]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission under AT(30-1)1516) **Unclassified**

The crystallographic structure of NaNbO_3 is investigated in the temperature region from -167°C to room temperature in order to provide a crystal model for this substance which has been reported to be both ferro- and antiferroelectric. The room temperature structure is found to be orthorhombic. At -167°C the structure is monoclinic with probable space group Cm . The c axial length is twice that of the pseudo-cubic cell. If the doubling of the c axial length is disregarded, then the structure can be interpreted as rhombohedral. At about -25°C a discontinuity occurs in the cell axial parameters and cell volume. A similar discontinuity occurs in the dielectric constant as well as a discontinuity at about -100°C . A model for the low temperature phase of the NaNbO_3 is presented. A second room temperature phase of the crystal is reported.

PSU.08:019 - PSU.08:022

PSU.08:019

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.]
University Park.

SOME NEW X-RAY AND NEUTRON STUDIES OF HYDROGEN BONDING (Abstract), by R. Pepinsky. [1957] [5]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission) Unclassified

Presented at Symposium on Hydrogen Bonding, Internat'l. Union of Pure and Appl. Chem. and Union of Chem. Soc. of Yugoslavia, Ljubljana (Yugoslavia), July 29-Aug. 2, 1957.

The structure of ferroelectric Rochelle salt has been solved by means of a joint x-ray and neutron analysis. The neutron analysis involves the use of maps constructed from the neutron scattering from the regular compound and one in which the hydrogen has been replaced by deuterium. The complete hydrogen bond system is described and the contribution of the hydrogen on the second central hydroxyl group of the tartrate ion to the spontaneous polarization is confirmed. The hydrogen positions and the role of the H-bond in the anti-ferroelectric transition of the tetragonal phase of ammonium dihydrogen phosphate have been determined by means of neutron diffraction. Tri-glycine fluoberyllate, silver glycinate, and a low-temperature phase of methylammonium aluminum sulfate alum are found to be ferroelectric. Polarization mechanisms for the first two and the crystallographic structure of the latter are given along with H-bonds for all of the systems. A low-temperature phase of ammonium iodide is antiferroelectric for which the transition mechanism and bonding is described. X-ray methods in three dimensions have been used to determine the structures and H-bonding of zinc-aspartate tri-hydrate, urea phosphate, and cycloserine hydrochloride.

PSU.08:020

Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

DIELECTRIC AND THERMAL STUDY OF TRI-GLYCINE SULFATE AND TRI-GLYCINE FLUOBERYLLATE, by S. Hoshino, T. Mitsui and others. [1957] [4]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs.) Unclassified

Published in Phys. Rev., v. 107: 1255-1258, Sept. 1, 1957.

The small field dielectric constants measured along the b crystallographic axis of tri-glycine sulfate and tri-glycine fluoberyllate show a pronounced anomaly at the Curie temperature of 48°C and 70°C, respectively.

The dielectric constants measured along the a and c axes are practically temperature-independent. In the vicinity of the Curie point, the square of the spontaneous polarization increases linearly with decreasing temperature. The transition of both salts is of the second order. Measurements of the specific heat as a function of temperature yield $\Delta S = 0.48$ cal/mol degree for tri-glycine sulfate, and $\Delta S = 1.17$ cal/mol degree for tri-glycine fluoberyllate. The results are discussed on the basis of Mueller's thermodynamic theory for ferroelectric transitions. (Contractor's abstract)

PSU.08:021

Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

FERROELECTRICITY IN AMMONIUM MONOCHLORO-ACETATE, by R. Pepinsky, Y. Okaya, and T. Mitsui. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs. under DA 36-039-sc-63233) Unclassified

Published in Acta Crystallographica, v. 10: 600-601, Sept. 10, 1957.

The room temperature form of ammonium monochloroacetate is found to exhibit a dielectric anomaly at -150°C. The crystal shows spontaneous polarization $P_s = 0.1$ microcoul/cm² and ferroelectric hysteresis below this transition temperature. The coercive field at -170°C is found to be about 10 kv/cm and the transition is apparently of first order.

PSU.08:022

Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

FERROELECTRICITY IN GLYCINE SILVER NITRATE, by R. Pepinsky, Y. Okaya and others. [1957] [2]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs.) Unclassified

Published in Phys. Rev., v. 107: 1538-1539, Sept. 15, 1957.

Glycine silver nitrate, $\text{NH}_2\text{CH}_2\text{COOH} \cdot \text{AgNO}_3$, is ferroelectric below -55°C. At -195°C the spontaneous polarization is 0.55×10^{-6} coulomb/cm², and the coercive field is 740 v/cm. The transition appears to be of second order. A differential thermal analysis does not reveal a specific heat anomaly. No dielectric anomalies appear between 4°K and -55°C. The spontaneous polarization here, as in triglycine sulfate and isomorphs, is attributed to disturbance of the planarity of the glycine ion by the crystalline field. (Contractor's abstract)

PSU.08:023 - PSU.08:025

PSU.08:023

Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

ANOMALOUS DIELECTRIC DISPERSION AND FERROELECTRICITY IN THE ALUMS (Abstract), by K. Vedam and R. Pepinsky. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs. under DA 36-039-sc-72385) Unclassified

Presented at Pittsburgh Diffraction Conf., Pa., Nov. 6-8, 1957.

The temperature dependence of the dielectric behavior of ammonium iron alum has been investigated at a number of frequencies between 1 kc and 50 mc. The temperature at which the dielectric loss reaches a maximum is frequency-dependent, and this anomalous absorption can be represented by the Debye theory of relaxation. In addition to this Debye absorption, abrupt changes in E' and E'' are observed in this alum at a temperature which is independent of frequency. This temperature corresponds to that of the phase transition, the low-temperature phase of the crystal being ferroelectric. Similar investigations of other ammonium and methylammonium alums are discussed.

PSU.08:024

Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

SUPERSTRUCTURES AND TRANSITIONS IN K_2SO_4 -TYPE CRYSTALS (Abstract), by Y. Okaya and R. Pepinsky. [1957] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs. under DA 36-039-sc-72385) Unclassified

Presented at Pittsburgh Diffraction Conf., Pa., Nov. 6-8, 1957.

The discovery of ferroelectricity in low-temperature phases of $(NH_4)_2SO_4$ and $(NH_4)_2BeF_4$ has prompted re-examination of the room-temperature structures of these crystals, and analysis of the ferroelectric phases as well. It is found that the room-temperature cells of both $(NH_4)_2SO_4$ and $(NH_4)_2BeF_4$ are not as reported in the literature, but show superstructures; and as the crystals become ferroelectric, the superstructures become more complex. The case of $(NH_4)_2BeF_4$ is given as an example:

(1) approximate (basic) cell and symmetry at room temperature: $a_1 = 7.64A$, $b_1 = 5.91A$, $c_1 = 10.44A$; space

group = Pnma (or, less probably, Pn2a). (2) true cell at room temperature: $a_2 = 2a_1$, $b_2 = 2b_1$, $c_2 = 2c_1$; space

group = Abma (or, less probably, Ab2a). Some stacking disorder along c_2 is observed in this phase. (3) approximate (basic) ferroelectric cell (below $-100^\circ C$):

$a_3 \approx 2a_1$, $b_3 \approx b_1$, $c_3 \approx c_1$, space group = Pna2₁. c_3 = polar axis. (4) true ferroelectric cell (below $-100^\circ C$): $a_4 \approx 2a_1$, $b_4 \approx 2b_1$, $c_4 \approx 2c_1$. Between $-135^\circ C$ and $+135^\circ C$ there is only the single (ferroelectric) transition at $\approx -95^\circ C$. The transition energy $\Delta Q = 0.14$ kcal/mol, and the entropy of the transition is 0.83 cal/mol-deg. The approximate (basic) cell of $(NH_4)_2SO_4$ at room temperature is isomorphous with that of $(NH_4)_2BeF_4$ at that temperature; the true room-temperature structure shows superstructure, but this differs from one sample to another. The energy of the ferroelectric transition is $\Delta Q = 0.55$ kcal/mol, and the entropy of the transition is 2.5 cal/mol-deg. The shape of the $(NH_4)_2SO_4$ specific heat vs temperature curve in the neighborhood of the transition point is of the λ -type; the curve for $(NH_4)_2BeF_4$ shows a broad maximum in the neighborhood of the transition, and the height of the maximum is very much less than that for $(NH_4)_2SO_4$. The latter crystal shows only the one transition in the temperature range from $-135^\circ C$ to $+170^\circ C$. X-ray and thermal measurements have been made on a number of other members of the K_2SO_4 -type class, and on various mixed crystals in the class. The superstructure lines for $(NH_4)_2(BeF_4, SO_4)$ resemble maxima in a fiber diagram. $(NH_4, Rb)_2SO_4$ x-ray patterns show disorder in the (a,c) plane. The nature of transitions, superstructures and disorder in various other members and mixed crystals from the K_2SO_4 family are discussed.

PSU.08:025

Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

INSTRUMENTATION FOR DIFFRACTION, MICRO-OPTICAL, MORPHOLOGICAL AND DIELECTRIC INVESTIGATIONS OF CRYSTALS (Abstract), by R. Pepinsky, K. Drenck and others. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Office of Ordnance Research, Signal Corps Engineering Labs., and Atomic Energy Commission) Unclassified

Presented at Congress of Internat'l. Union of Crystallography, Montreal, Que. (Canada), July 10-17, 1957.

Published in Acta Crystallographica, v. 10: 739, Dec. 10, 1957.

The following new instruments are described: a miniaturized Weissenberg camera, permitting a focal-spot to film distance of 4.3 cm, for use with a micro-focus x-ray

PSU.08:026 - PSU.08:028

tube; a new Weissenberg for studies at liquid helium temperature; a new heating camera for the Unicam and Super Weissenbergs; a new heating chamber for powder and single-crystal studies on the G.E. XRD-3 instrument; a new servo-controlled miniaturized x-ray and neutron single-crystal counter goniometer; several new microscope stages for observations at liquid helium and liquid nitrogen temperatures, and a liquid-nitrogen dewar for studies on the Waldmann Chemists' microscope; a new two-circle photoelectric optical goniometer for morphological measurements, which automatically records stereographic projections; a new instrument for single-crystal piezoelectric measurements; new multiple-crystal holders for dielectric measurements at low and high temperatures; a self-balancing bridge and servo-driven recorder for automatic measurement and plotting of dielectric constants versus temperature; a new type of temperature controller and indicator, for use in thermostats at temperature from -196° to $+500^{\circ}\text{C}$, with a control accuracy of $\pm 0.05^{\circ}\text{C}$; a system for electrode evaporative coating of hydroscopic crystals, for dielectric studies; and a new string saw for oriented crystal cutting.

PSU.08:026

Pennsylvania State U. [X-Ray and Crystal Analysis Lab., University Park.

OPTICAL, DIELECTRIC, DILATOMETRIC, THERMAL AND X-RAY STUDIES OF CRYSTAL TRANSITIONS (Abstract), by R. Pepinsky, F. Jona and others. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., Atomic Energy Commission, and Office of Naval Research) Unclassified

Presented at Congress of Internat'l. Union of Crystallography, Montreal, Que. (Canada), July 10-17, 1957.

Published in Acta Crystallographica, v. 10: 835, Dec. 10, 1957.

Optical observations have revealed reversible low-temperature transitions in a large number of complex ion salts, divalent metal fluoborates and perchlorates, monovalent and divalent metal and amine hexafluorophosphates, urea and thiourea salts, basic beryllium acetate, various $\text{NH}_4^+-\text{Me}^{\text{II}}$ double sulfates, various

$\text{Me}^{\text{II}}(\text{Me}^{\text{II}})_2$ hexa-propionates, $\text{K}_3\text{Na}(\text{CrO}_4)_2$, etc., a variety of ammonium and substituted ammonium alums. Reversible high-temperature transitions have been observed in a large series of normal- and isoalkylamine phosphates and arsenates, various complex ion salts, tetraethylamine and other amine fluoborates, divalent metal fluoborates, etc. Dielectric measurements indicate anomalies in various of these, in $(\text{NH}_4)_2\text{S}_2\text{O}_3$ and many other ammonium salts, and in various perovskites and pseudoperovskites, including mixed crystals.

Dielectric hysteresis observations are reported for various new ferroelectrics, as are dilatometric and differential thermal analyses. X-ray diffraction studies are reported of the structures and transition mechanisms in various ferroelectrics and antiferroelectrics.

PSU.08:027

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

X-RAY CRYSTALLOGRAPHIC STUDY OF ROOM TEMPERATURE MODIFICATION OF MONOMETHYLAMMONIUM ALUMINUM SULFATE ALUM, (CH_3NH_3)

$[\text{Al}(\text{H}_2\text{O})_6] (\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, by Y. Okaya, M. S. Ahmed and others. [1957] [12]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs. under DA 36-039-sc-63233) Unclassified

Published in Zettschr. Krist., v. 109: 367-378, Dec. 1957.

Also published in Zettschr. Phys. Chemie, New Series, v. 13: 367-378, 1957.

The structure of the alum monomethylammonium aluminum sulfate dodecahydrate at room temperature has been redetermined. The CH_3NH_3^+ ions do not lie along the cube body diagonal, but are arranged statistically at an angle to this diagonal. The disordered arrangement of these ions does not appear to be of thermal origin. The $[\text{Al}(\text{H}_2\text{O})_6]^3$ octahedra are slightly flattened, with trigonal symmetry, and with an Al - O separation of 1.88₆ Å. The CH_3NH_3^+ ion is surrounded by a distorted octahedron of water molecules. The SO_4^{2-} ion possesses trigonal symmetry: three S - O separations are 1.49₄ Å, and one is 1.47₃ Å. The complex hydrogen-bond system, involving all types of oxygens, is described. The crystal becomes ferroelectric below -96°C . The low-temperature phase has symmetry $\text{P}2_1$. (Contractor's abstract)

PSU.08:028

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

PRELIMINARY X-RAY STUDY OF THE NON-FERROELECTRIC PHASES OF ROCHELLE SALT, by F.

Mazzi, F. Jona, and R. Pepinsky. [1957] [16]p. incl. illus. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs. under DA 36-039-sc-63233, and Atomic Energy Commission under AT(30-1)1516) Unclassified

PSU.08:029 - PSU.08:031

Published in Zeitschr. Krist., v. 108: 359-374, 1957.

In order to understand the nature of the two transitions in Rochelle salt, at -18°C and $+23^{\circ}\text{C}$, between which points the crystal is ferroelectric, the structures of the two non-ferroelectric phases have been studied with x-rays, preparatory to neutron examination. Both non-ferroelectric phases are in space group $P2_12_12$. Multi-film Weissenberg data with $\text{CuK}\alpha$, and with specimens encased in pyrex, were obtained at temperatures -64°C , 0°C and $+35^{\circ}\text{C}$. Orthorhombic symmetry was assumed for all three phases, and six (001) projections were computed on X-RAC.

PSU.08:029

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

A NEW ROOM-TEMPERATURE FERROELECTRIC, by R. Pepinsky, K. Vedam, and Y. Okaya. [1958] [12]p. incl. diagrs. table, refs. (AFOSR-TN-58-217) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs. under DA 36-039-sc-72385) AD 234954 Unclassified

Also published in Phys. Rev., v. 110: 1309-1311, June 15, 1958.

The neutral-salt complex with glycine, di-glycine manganous chloride dihydrate, $(\text{NH}_2\text{CH}_2\text{COOH})_2 \cdot \text{MnCl}_2 \cdot 2\text{H}_2\text{O}$, is found to be ferroelectric from low temperatures to $+55^{\circ}\text{C}$. Above the latter temperature the conductivity suddenly becomes excessive. At room temperature the spontaneous polarization is 1.3×10^{-6} coulombs/cm² and the coercive field is 5.6 kv/cm. A non-reversible surface change is observable optically above 72°C , probably due to loss of H_2O .

Thermal measurements indicate onset of water loss above 35°C ; electrical conductivity increases sharply and irreversibly above 55°C , and care must be taken to prevent dehydration even at room temperature. No Curie temperature can be observed. X-ray measurements of this hitherto unreported salt show space group $P2_1$, $a = 9.96 \text{ \AA}$, $b = 8.53 \text{ \AA}$, $c = 6.86 \text{ \AA}$, $\beta = 107 \pm 0.5^{\circ}$, density = 1.875_0 g/cc , and two formula units per cell. The ferroelectric axis is along b . The dielectric constants at room temperature are $\epsilon_a = 6.6$, $\epsilon_b = 8.1$, $\epsilon_c = 7.4$; and these decrease linearly and only very slightly as the temperature is lowered to 77°K . The corresponding neutral-salt complex of two glycines with MnBr_2 is not isomorphous, occurring as a tri-hydrate, and is not ferroelectric. It has not been possible to find any metal which will replace manganese and form an isomorphous crystal. (Contractor's abstract)

PSU.08:030

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

FERROELECTRICITY IN DI-GLYCINE NITRATE, $(\text{NH}_2\text{CH}_2\text{COOH})_2 \cdot \text{HNO}_3$, by R. Pepinsky, K. Vedam and others. [1958] 12p. incl. diagrs. table. (AFOSR-TN-58-219) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs. under DA 36-039-sc-72385) AD 154120 Unclassified

Also published in Phys. Rev., v. 111: 430-432, July 15, 1958.

$(\text{Glycine})_2 \cdot \text{HNO}_3$ is ferroelectric below -67°C . The room-temperature phase is monoclinic, space group $P2_1/a$, with $a = 9.49_6 \text{ \AA}$, $b = 5.10_7 \text{ \AA}$, $c = 9.35_0 \text{ \AA}$, $\beta = 98.8^{\circ}$, $\rho_{\text{obs}} = 1.581_0 \text{ g/cc}$, and $Z = 2$. The nitrate groups must be disordered or rotating in this phase, since they are at centers of symmetry. The symmetry of the ferroelectric phase is Pa , as established from systematic absences and the fact that spontaneous polarization appears along the room-temperature $[101]$ direction below -67°C . The dielectric constant $\epsilon_{[101]}$, at 10 kc and 5 v/cm, is 14 at room temperature, rises to a sharp peak of ~ 600 at -67°C , and falls to ~ 12 at -180°C . The transition appears to be of second order. At -77°C the spontaneous polarization is $0.60 \text{ } \mu\text{coul/cm}^2$, and the coercive field is 400 v/cm. A specific heat anomaly similar to that in $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$ and $(\text{glycine})_3 \cdot \text{H}_2\text{BeF}_4$ is observed, with $\Delta E = 0.15 \text{ kcal/mol}$ and $\Delta S = 0.74 \text{ cal/mol deg}$. (Contractor's abstract)

PSU.08:031

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

ANOMALOUS DIELECTRIC ABSORPTION AND FERROELECTRIC TRANSITIONS IN ALUM (Abstract), by K. Vedam and R. Pepinsky. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(603)35] and Signal Corps Engineering Labs. under [DA 36-039-sc-63233]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 44, Jan. 29, 1958.

Examination of the results of Guillien and of Le Montagner on dielectric properties of alums reveals that the temperature T_m at which the dielectric loss

PSU.08:032 - PSU.08:034

reaches a maximum is frequency-dependent, and that this anomalous absorption can be represented by Debye's theory of relaxation. No anomaly could be detected by these investigators at the ferroelectric transition temperatures. Redetermination of the dielectric behavior of $(\text{NH}_4)\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ at a number of frequencies between 10 kc and 50 mc reveals small but reproducible anomalies in E' and E'' at 88° K. Similar anomalies have been detected at microwave frequencies by Griffiths and Powell. Deuteration of the alum increases the value of T_m , but does not alter the transition temperature.

Similar observations are reported for other ferroelectric alums.

PSU.08:032

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

DIELECTRIC AND THERMAL STUDIES OF FERROELECTRIC TRANSITIONS IN $(\text{NH}_4)_2\text{SO}_4$ AND

$(\text{NH}_4)_2\text{BeF}_4$ (Abstract), by S. Hoshino, K. Vedam and others. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Signal Corps Engineering Labs. under [DA 36-039-sc-63233], and Atomic Energy Commission under [AT(30-1)1516])

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 44, Jan. 29, 1958.

Measurements of dielectric properties, specific heats and thermal expansions of the ferroelectric transitions in $(\text{NH}_4)_2\text{SO}_4$ and $(\text{NH}_4)_2\text{BeF}_4$ and mixed crystals of these have been performed under various conditions. It is found that the nature of the transition is affected by the previous history of the samples: i.e., heat treatment, application of electric fields, etc. For example, some samples of $(\text{NH}_4)_2\text{BeF}_4$ which do not show double ferroelectric hysteresis loops characteristic of a first-order transition exhibit this property after thermal annealing. A sample of $(\text{NH}_4)_2\text{SO}_4$ which was annealed at 75°C shows a typical lambda-type specific heat anomaly, while the sample without heat treatment shows quite different behavior. Results are discussed in the light of a parallel structural study.

PSU.08:033

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

NON-ISOMORPHISM OF FERROELECTRIC PHASES AND SUPERSTRUCTURES IN $(\text{NH}_4)_2\text{SO}_4$ AND

$(\text{NH}_4)_2\text{BeF}_4$ (Abstract), by R. Pepinsky, Y. Okaya and others. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Signal Corps Engineering Labs. under [DA 36-039-sc-63233], and Atomic Energy Commission under [AT(30-1)1516])

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 44, Jan. 29, 1958.

$(\text{NH}_4)_2\text{SO}_4$ and $(\text{NH}_4)_2\text{BeF}_4$ become ferroelectric below -49.5°C and -97°C, respectively. Although these crystals were reported as isomorphous, reexamination by x-rays reveals differences in room-temperature symmetries and in directions of polar axes in the ferroelectric phases. Cell constants, in angstroms, are $a = 7.49$, $b = 10.39$, $c = 5.89$ for $(\text{NH}_4)_2\text{BeF}_4$ and $a = 7.729$, $b = 10.560$, $c = 5.951$ for $(\text{NH}_4)_2\text{SO}_4$. The room-temperature space group for both is Pnam if superstructuring is disregarded; superstructuring appears in all $(\text{NH}_4)_2\text{BeF}_4$ and some $(\text{NH}_4)_2\text{SO}_4$ samples, and doubles b and c , leading to space group Acam . Below its Curie point $(\text{NH}_4)_2\text{BeF}_4$ has a doubled, with symmetry $\text{Ac}2_1a$. Non-superstructured $(\text{NH}_4)_2\text{SO}_4$ shows neither dimensional doubling nor change in systematic absences at low temperature; the space group is $\text{Pna}2_1$. Polar directions observed dielectrically are b in $(\text{NH}_4)_2\text{BeF}_4$ and c in $(\text{NH}_4)_2\text{SO}_4$, in agreement with space-group requirements. X-ray, dielectric and thermal measurements are reported on $(\text{NH}_4)_2(\text{BeF}_4, \text{SO}_4)$ and other K_2SO_4 -type crystals.

PSU.08:034

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

SOME NEW X-RAY AND NEUTRON STUDIES OF HYDROGEN BONDING, by R. Pepinsky. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission) Unclassified

Presented at Internat'l. Conf. on Current Problems in Crystal Physics, Massachusetts Inst. of Tech., Cambridge, July 1-6, 1957.

Published in Rev. Modern Phys., v. 30: 100, Jan. 1958.

Three-dimensional refinement on the IBM 704 machine of x-ray analyses of cycloserine hydrochloride, zinc aspartate trihydrate, and urea phosphate has revealed interesting H-bond systems in these crystals. The

PSU.08:035 - PSU.08:037

cycloserine HCl analysis reveals six short intermolecular distances indicated O-H...O, N-H...O, and N-H...Cl bonds. A three-dimensional refinement of the structure of zinc aspartate trihydrate reveals H bonding which leads to the ring structure proposed by Steward and Thompson for a cyclic structure for asparagine. The structure of urea phosphate shows very strong H bonding throughout, indicating hydrogen sharing by two bonds in two cases. The structure of ferroelectric Rochelle salt has been solved, by a joint x-ray and neutron analysis. The contribution of the hydrogen (or deuterium) on the second central hydroxyl group of the tartrate ion to the spontaneous polarization is confirmed. Hydrogen positions have been found in the tetragonal phase of ammonium dihydrogen phosphate, by neutron diffraction. The interesting feature of the O-H...O bonds here is that the hydrogens do not lie on a line connecting the two O's. Very short intermolecular distances appear in the structure of the explosive HMX, cyclotetramethylene tetra-nitramine. Distances of 3.03 Å and 3.15 Å are found between one O of a nitro group and methylene C's of two adjacent molecules. It is demonstrable that H's are not involved in these remarkably short bonds. This compound must be a self-intermolecular-complex; and, if so, this is the reliable example of short intermolecular distances in such a complex. The structures of these organic intermolecular complexes, and the physical nature of the bonding, in which, in general, hydrogens are not involved, is a foremost problem in the modern valence theory; and further x-ray studies of these compounds are a pressing matter. Some problems in the stereochemistry of hydrogen bonds are described, as are problems of dielectric anomalies and other transition phenomena involving H bonds. The mechanisms of the ferroelectric transitions in the ammonium and organic amine alums, $(\text{NH}_4)_2\text{SO}_4$, $\text{Cd}_2(\text{NH}_4)_2(\text{SO}_4)_3$, $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$ and isomorphs, and thiourea; the nature of the polarization in guanidinium aluminum sulfate hexahydrate and isomorphs, and the anomalies in the hydrogen halides, are of particular interest.

PSU.08:035

Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

NON-ISOMORPHISM OF FERROELECTRIC PHASES OF AMMONIUM SULFATE AND AMMONIUM FLUOBERYLLATE, by Y. Okaya, K. Vedam and R. Pepinsky. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs. under DA 36-039-sc-72385, and Atomic Energy Commission under AT(30-1)1516) Unclassified

Published in Acta Crystallographica, v. 11: 307, Apr. 10, 1958.

It is now reported that ammonium sulfate and fluoberyllate crystals are not isomorphous in their low temperature (ferroelectric) phases even though the room

temperature phases are basically isomorphous. The room temperature phase of $(\text{NH}_4)_2\text{SO}_4$ sometimes shows super-structuring while the basic cell of $(\text{NH}_4)_2\text{BeF}_4$ is super-structured. The ferroelectric symmetry of the sulfate is $\text{Pn}2_1$ and that of the fluoberyllate is $\text{Pn}2_1a$, while the directions of spontaneous polarization in the two crystals are oriented in directions which are 90 degrees with respect to each other. The dielectric and thermal studies of the crystals have been completed and the x-ray and neutron analyses are in progress. Other K_2SO_4 crystal types have also been studied.

PSU.08:036

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.]
University Park.

A NEUTRON STRUCTURE ANALYSIS OF TETRAGONAL $\text{NH}_4\text{H}_2\text{PO}_4$, by L. Tenzer, B. C. Frazer, and R.

Pepinsky. [1958] [5]p. incl. diagr. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Atomic Energy Commission) Unclassified

Published in Acta Crystallographica, v. 11: 505-509, July 1958.

The structure of tetragonal $\text{NH}_4\text{H}_2\text{PO}_4$ has been determined in a single-crystal neutron-diffraction study. The N-H...O and O-H...O bond systems suggested in earlier x-ray investigations were confirmed. The H_2PO_4^- network is very similar to that found in KH_2PO_4 ; the only significant difference observed was in the angle between the P-O and O-H...O bonds. The ammonium ion was found to be only slightly distorted from a rectangular tetrahedral arrangement. Considerable distortion would be necessary for linear N-H...O bonds. The observed angle between the N-H bond and the line joining nitrogen and oxygen centers was about 14°. In order to achieve good agreement between calculated and observed data it was necessary to introduce anisotropic thermal vibration parameters. The final value of the discrepancy factor was 8.9%. (Contractor's abstract)

PSU.08:037

Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

THEORY OF THE FERROELECTRIC EFFECT IN ROCHELLE SALT, by T. Mitsui. [1958] [9]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission) Unclassified

PSU.08:038 - PSU.08:040

Published in Phys. Rev., v. 111: 1259-1267, Sept. 1, 1958.

Mueller's phenomenological theory of Rochelle salt, $\text{NaKC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$, has been generalized, and the properties of the clamped crystal described. A local field theory of the clamped crystal has been developed on the basis of the structure analysis of Frazer, Danner, and Pepinsky. A phase diagram is given which shows conditions for the occurrence of ferroelectricity. It has been shown that the difficulties of Mason and Devonshire's theories are the results of too simplified assumptions on the coefficients of the local field. Various quantities which appear in the theory have been calculated using the fact that the reciprocal susceptibility of the clamped crystal has a single zero value. The calculated coefficients which appear in the Taylor series expansion of Helmholtz free energy agree well with those predicted by the phenomenological theory. An explanation is given for the properties of the mixed crystal series, $\text{Na}[K_\alpha(\text{NH}_4)_{1-\alpha}]\text{C}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. (Contractor's abstract, modified)

PSU.08:039

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

ROOM-TEMPERATURE FERROELECTRICITY IN LITHIUM HYDRAZINIUM SULFATE, $\text{Li}(\text{N}_2\text{H}_5)\text{SO}_4$, by R. Pepinsky, K. Vedam and others. [1958] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Signal Corps Engineering Labs.)
Unclassified

Published in Phys. Rev., v. 111: 1467-1468, Sept. 15, 1958.

$\text{Li}(\text{N}_2\text{H}_5)\text{SO}_4$ is ferroelectric over the temperature range from below -15°C to above 80°C , and shows no dielectric peaks between -196°C and 140°C . No thermal anomalies are observed. The crystals are orthorhombic, space group $\text{Pbn}2_1$, with $a = 8.96_9 \text{ \AA}$, $b = 9.91_3 \text{ \AA}$, $c = 5.17_8 \text{ \AA}$, and the ferroelectric axis is, of course, along c ; $p = 1.996 \text{ g/cc}$, and there are 4 molecules per cell. The coercive field is about 320 volts/cm at room temperature, and the spontaneous polarization is $0.30 \text{ microcoulomb/cm}^2$. Beautiful large crystals can be grown from water by a variety of methods. After electroding, the crystal plates should be protected by silicone oil. Without such protection, reaction with normal atmosphere for prolonged time results in excessive conductivity.

PSU.08:038

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

AMMONIUM HYDROGEN SULFATE: A NEW FERROELECTRIC WITH LOW COERCIVE FIELD, by R. Pepinsky, K. Vedam and others. [1958] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 111: 1508-1510, Sept. 15, 1958.

It has been found that $(\text{NH}_4)\text{HSO}_4$ is ferroelectric in the temperature range between -3°C and -119°C . The symmetry of the room-temperature phase is $\text{P}2_1/c$; the ferroelectric phase is monoclinic, with space group $\text{P}c$; and the lowest phase, which is piezoelectric has triclinic symmetry $\text{P}1$. All three phases are pseudo-orthorhombic. The coercive field is very low, about 150 v/cm at -13°C . The spontaneous polarization P_s is about $0.4 \text{ microcoul/cm}^2$ at that temperature, and rises to a maximum of about $0.8 \text{ microcoul/cm}^2$ just above -119°C . P_s falls to zero abruptly at the lower transition point. The higher transition is of second order, and the lower of first order. (Contractor's abstract)

PSU.08:040

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

CRYSTAL STRUCTURAL STUDIES OF SOME NEW FERROELECTRICS (Abstract), by K. Vedam and R. Pepinsky. 1958, 1p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35 and Atomic Energy Commission under AT(30-1)1516)
Unclassified

Presented at meeting of the Inorg. Chem. Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Published in 134th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 17-N.

Structural mechanisms of the transitions in the various new ferroelectric crystals under study are described, insofar as they are known. Results on extensive x-ray, dielectric, thermal and optical measurements are described for the following ferroelectrics: $(\text{NH}_4)_2\text{SO}_4$, $(\text{NH}_4)_2\text{BeF}_4$, the various ammonium and methylammonium alums, $\text{Li}(\text{N}_2\text{H}_5)\text{SO}_4$, $(\text{NH}_4)\text{HSO}_4$, $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$, $(\text{glycine})_2 \cdot \text{MnCl}_2 \cdot 2\text{H}_2\text{O}$, $(\text{glycine}) \cdot \text{AgNO}_3$, and

PSU.08:041; PEN.01:006; PEN.02:002

(glycine) $_2$ ·HNO $_3$. It is shown that (NH $_4$) $_2$ SO $_4$ and (NH $_4$) $_2$ BeF $_4$ are not exactly isomorphous, as was thought heretofore; furthermore, the polar axes and the transition mechanisms for the two are markedly different. A detailed structure analysis of the important ferroelectric (glycine) $_3$ ·H $_2$ SO $_4$ reveals that O-H...O and N-H...O bonds play a prominent role in the ferroelectric behavior. This appears to be the case for all of the above-listed ferroelectrics. The antiferroelectric transitions in NH $_4$ PF $_6$ ·NH $_4$ F and (NH $_4$) $_3$ H(SO $_4$) $_2$ are also discussed.

PSU.08:041

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.]
University Park.

DIELECTRIC AND THERMAL STUDY OF (NH $_4$) $_2$ SO $_4$
AND (NH $_4$) $_2$ BeF $_4$ TRANSITIONS, by S. Hoshino, K.

Vedam and others. [1958] [8]p. incl. diagrs. refs.
(Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Signal Corps Engineering Labs., and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 112: 405-412, Oct. 15, 1958.

The behavior of the various dielectric properties, specific heat, and thermal expansion of (NH $_4$) $_2$ SO $_4$ and

(NH $_4$) $_2$ BeF $_4$ has been studied in detail under various experimental conditions, with particular reference to the ferroelectric transitions in these crystals. The curves of dielectric constant vs temperature follow a relationship other than the Curie-Weiss law. The shift of the transition temperature as reported in the literature could not be detected even under extreme experimental conditions. The transition energy and entropy change have been evaluated from a C $_p$ vs T curve. The

variation of the lattice parameters and the unit cell volumes with temperature has been measured by the x-ray method. The transition of (NH $_4$) $_2$ SO $_4$ appears to be of first order, while that of (NH $_4$) $_2$ BeF $_4$ is also of first

but very close to second-order. Deuteration of these crystals does not affect the transition of (NH $_4$) $_2$ SO $_4$; but in the case of (NH $_4$) $_2$ BeF $_4$ the transition temperature is raised by 3°C by deuteration, and the transition energy is also increased. The phase diagram of (NH $_4$) $_2$ SO $_4$ -(NH $_4$) $_2$ BeF $_4$ system is given. (Contractor's abstract)

PEN.01:006

Pennsylvania U., Philadelphia.

EFFECT ON THE ENERGY OF INCREASED FLEXI-

BILITY IN THE SEPARABLE FACTOR OF HYLLERAAS-TYPE ATOMIC WAVE FUNCTIONS FROM H $^-$ TO O VII, by L. C. Green, S. Matsushima and others. [1958] [5]p. incl. table, refs. [In cooperation with Haverford Coll., Strawbridge Observatory, Pa.] (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)660], National Science Foundation, and Office of Naval Research) Unclassified

Published in Phys. Rev., v. 112: 1187-1191, Nov. 15, 1958.

A number of wave functions of the form $f(r_1)f(r_2)g(r_1, r_2, r_{12})$ are applied to the two-electron systems from H $^-$ to O VII. Various analytic expressions for f and g are employed. The values of the various parameters in f and g are chosen to yield the minimum energy. The wave functions, the values of the parameters, and the minimum energies are tabulated. Twenty of the twenty-six functions tabulated are presented here for the first time. For five of the remaining six functions the values of the parameters and the energies have been recomputed. The energies obtained with these wave functions as well as with functions investigated by others are examined to ascertain what improvement in the energy results from considering other functional forms for $f(r)$ than the customary negative exponential. In the case of H $^-$, it is clear that certain types of flexibility in $f(r)$ can substantially improve the energies obtained with the simpler functions. For larger nuclear charge the improvement is definite but smaller. The functions obtained are of interest in themselves. Several of them give the lowest energies for H $^-$ so far found for various specific numbers of parameters. Beyond Li II, no simple wave functions involving the interelectron distance were previously available.

PEN.02:002

Pennsylvania U., Philadelphia.

ON THE HYDRODYNAMIC STABILITY OF CURVED LAMINAR LAYERS, by M. Lessen. [1958] [5]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)124] and General Electric Co.)

Unclassified

Published in Zeitschr. Angew. Math. Mech. (ZAMM), v. 38: 95-99, Mar./Apr. 1958.

The stability of curved laminar compressible flows is examined, and it is found that instabilities in the flow fields about bodies moving at high speed may exist under certain circumstances. The general disturbance equations are derived and simplified cases are discussed. Whereas in the case of incompressible flows, the instability is due to the kinematics of the flow field, for the compressible case, thermodynamic factors are also of importance. (Contractor's abstract)

PEN.03:003; PEN.04:006

PEN.03:003

Pennsylvania U. Dept. of Mathematics, Philadelphia.

MEAN-L-STABLE SYSTEMS, by J. Auslander. June 1957, 48p. refs. (AFOSR-TN-57-460) (AF 18(600)1116) AD 136451 Unclassified

Also published in Illinois Jour. Math., v. 3: 566-579, Dec. 1959.

A study is made of the topological and measure theoretic properties of the discrete flow generated by a homeomorphism of a metric space onto itself. The metric space is usually assumed to be compact. An analysis is made of mean-L-stable systems by means of the ergodic theorem and the theory of Kryloff and Bogolouboff. Several results connecting mean-L-stability with various almost periodicity properties are obtained. A decomposition theorem for the systems is proved. Examples of the systems and open questions are discussed, with a detailed analysis being carried out of a modified version of a complicated example due to Floyd (Bull. Amer. Math. Soc., v. 55: 957-960, 1949). Statements and proofs of the results on upper density, lower density, and density, which are needed for the analysis of mean-L-stable systems are included in an appendix.

PEN.03:004

Pennsylvania U. Dept. of Mathematics, Philadelphia.

EQUICONTINUITY AND ALMOST PERIODIC FUNCTIONS, by R. Ellis. Nov. 3, 1958, 12p. (AFOSR-TN-58-118) (AF 18(600)1116) AD 152026; PB 137066 Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 637-643, Aug. 1959.

Let X be a separate uniform space, $C(X, X)$ the set of continuous functions of X into X , and $C(X)$ the set of real valued continuous functions on X provided with the topology of uniform convergence. For $f \in C(X)$ and $a \in C(X, X)$, fa will denote that element of $C(X)$ such that $(fa)(x) = f(ax)$ ($x \in X$). Let $f \in C(X)$ and $A \subset C(X, X)$. Then f is said to be almost periodic with respect to A if $fa = [fa \mid a \in A]$ is a relatively compact subset of $C(X)$. The behavior of A is studied by means of its almost period functions. In particular it is shown that if there are enough of these, then A is equicontinuous.

PEN.03:005

Pennsylvania U. Dept. of Mathematics, Philadelphia.

DISTAL TRANSFORMATION GROUPS, by R. Ellis. Nov. 29, 1958, 7p. (AFOSR-TN-58-181) (AF 18(600)-1116) AD 152214 Unclassified

Also published in Pacific Jour. Math., v. 8: 401-405, 1958.

Distal is defined as a property strong enough to imply equicontinuity under suitable restrictions on a topological space and on a group of homeomorphisms. A recursive characterization of distal transformation groups is given in a general setting.

PEN.03:006

Pennsylvania U. Dept. of Mathematics, Philadelphia.

MINIMAL SETS: AN INTRODUCTION TO TOPOLOGICAL DYNAMICS, by W. H. Gottschalk. Oct. 30, 1958, 28p. Incl. refs. (AFOSR-TN-58-314) (AF 18(600)1116) AD 154218; PB 137067 Unclassified

Also published in Bull. Amer. Math. Soc., v. 64: 336-351, Nov. 1958.

A survey is given of some of the results, models, and problems of topological dynamics. For simplicity of presentation, attention is mostly confined to flows. (Contractor's abstract)

PEN.03:007

Pennsylvania U. Dept. of Mathematics, Philadelphia.

HOMOMORPHISMS OF TRANSFORMATION GROUPS, by R. Ellis and W. H. Gottschalk. [Oct. 1958] 38p. (AFOSR-TN-58-874) (AF 18(600)1116) AD 203914; PB 138147 Unclassified

Also published in Trans. Amer. Math. Soc., v. 94: 258-271, Feb. 1960.

Results of the study show that a transformation group with compact phase space and non-compact phase group gives rise to a compact topological group called its structure group. Let (X, T) be a transformation group with compact phase space X and with arbitrary phase group T . There exists least invariant closed equivalence relations S_d and S_e in X such that T is distal on X/S_d and T is equicontinuous on X/S_e . If (X, T) is locally almost periodic, then the 4 relations of S_d and S_e with the proximal and regionally proximal relations coincide. Such transformation groups are partially classifiable according to their structure groups. (ASTIA abstract)

PEN.04:006

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

ON VARIATION DIMINISHING TRANSFORMATIONS OF THE CIRCLE, by J. C. Mairhuber, I. J. Schoenberg, and R. E. Williamson. [1957] 1v. Incl. refs. (AFOSR-TN-57-606) (AF 18(600)1158) AD 136594 Unclassified

PEN.04:007 - PEN.04:009

Also published in Rend. Circ. Matem. Palermo, Series II, v. 8: 241-270, Sept.-Dec. 1959.

A study is presented of periodic variation diminishing kernels. The problem is to determine those periodic frequency functions $\Omega(t)$ with the property that the convolution transformation, $g(t) = \frac{1}{2\pi} \int_0^{2\pi} \Omega(t-\tau)f(\tau)d\tau$, be variation diminishing in the following sense: for every real continuous function $f(t)$ of period 2π , the convolution transformation should imply the inequality $v_c(g) \leq v_c(f)$. A function $\Omega(t)$ of this kind is called a periodic variation diminishing function. (ASTIA abstract)

PEN.04:007

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

REMARKS ON DE LA VALLÉE POUSSIN MEANS AND CONVEX CONFORMAL MAPS OF THE CIRCLE, by G. Pólya and I. J. Schoenberg. Nov. 1957, 1v. incl. refs. (AFOSR-TN-57-620) (AF 18(600)1158) AD 136609
Unclassified

Also published in Pacific Jour. Math., v. 8: 295-334, 1958.

The de la Vallée Poussin means are shown to possess shape-preserving properties to a higher degree than certain Cesaro means because of their variation-diminishing character. The principal result states that the inequalities $v_c(V_n) \leq Z_c(V_n) \leq v_c(f)$ hold for an arbitrary integrable function $f(t)$. $Z_c(V_n)$ denotes the number of real zeros of $V_n(t)$ within a period including multiplicities; $v_c(f)$ is the number of cyclic variations of the sign of $f(t)$, a real-valued function of period 2π ; and $v_c(V_n)$ is the number of variations of sign of the de la Vallée Poussin means or V-means. The applications of the variation-diminishing property of V-means are discussed. Bernstein polynomials have shape-preserving properties relative to functions $f(x)$ defined in a finite interval which are analogous to that of the V-means for the functions of period 2π . A conjecture is presented on power series which represent a conformal 1-1 mapping of the unit circle onto a convex domain. (ASTIA abstract)

PEN.04:008

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

SPLINE FUNCTIONS, CONVEX CURVES AND MECHANICAL QUADRATURE, by I. J. Schoenberg. [1958] [6]p. [AF 18(600)1158]
Unclassified

Published in Bull. Amer. Math. Soc., v. 64: 352-357, Nov. 1958.

By a spline function of degree $n-1$ is meant a function of the form

$$S_{n-1,k}(x) = P_{n-1}(x) + \sum_{v=1}^k C_v(x-\xi_v)^{n-1},$$

where $P_{n-1}(x)$ is a polynomial of degree $\leq n-1$ and

$x^{n-1} = x^{n-1}$ for $x \geq 0$ and 0 if $x < 0$. In this research announcement a fundamental theorem of algebra is given for spline functions and applications are indicated to mechanical quadrature formulas of Gauss and Radau type. The determination of the knots (ξ_v) of a spline

function with given zeros is made to depend upon a refinement of a theorem of Carathéodory on convex hulls. (Math. Rev. abstract)

PEN.04:009

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

SOME EXTREMAL PROBLEMS FOR POSITIVE DEFINITE SEQUENCES AND RELATED EXTREMAL CONFORMAL MAPS OF THE CIRCLE, by I. J. Schoenberg. [1958] [10]p. [AF 18(600)1158]
Unclassified

Published in Nederl. Akad. Wetensch. Proc., Indag. Math., Ser. A, v. 61: 28-37, 1958.

Let $\phi(t)$ be a positive mass distribution of total mass 1 on a circumference of radius 1, and let $\mu_v = \oint e^{ivt} \phi(t) dt$ ($v = 0, \pm 1, \pm 2, \dots$). Suppose that ϕ has its entire mass contained in an arc $\alpha \leq t \leq \alpha + \lambda$ ($0 < \lambda < 2\pi$) and has moments $\tilde{\mu}_v$ such that $\tilde{\mu}_v = 0$ if $v = n_1, n_2, \dots$ ($1 < n_1 < n_2 < \dots$). Next let $\tilde{F}(z) = z + \sum_{v=1}^{\infty} \tilde{c}_n z^{nv}$ map $|z| < 1$ onto a schlicht and convex domain \tilde{D} such that an arc $z = e^{it}$ ($\beta \leq t \leq \beta + \lambda$) maps onto a finite straight segment S in the boundary of \tilde{D} . The following two theorems are first proved: (1) For every distribution $\phi(t)$ with the property $\mu_v = 0$ for $v = n_1, n_2, \dots$, the inequality $|\mu_1| \leq |\tilde{\mu}_1|$ holds, clearly with equality if $\phi = \tilde{\phi}$. (2) Let $F(z) = z + \sum_{v=1}^{\infty} c_n z^{nv}$ map $|z| < 1$ onto a schlicht, convex domain D . Then D contains the circle $|w| < |\tilde{\mu}_1|$. For \tilde{D} the segment S is tangent to the circle $w = \tilde{\mu}_1$ at some point of S between its end points. By specializing $\tilde{\phi}$ several applications of the above theorems are given. For example, it is proved that the image of the unit circle under schlicht, convex mappings of the form $F(z) = z + c_2 z^2 + c_4 z^4 + c_6 z^6 + \dots$ covers the circle $w = 2^{-1/2}$. Similarly, under schlicht, convex mappings

PEN.11:001, 002; PEN.06:023, 024

of the form $F(z) = z + c_{k+1}z^{k+1} + c_{2k+1}z^{2k+1} + \dots + c_{v_{k+1}}z^{k+1} + \dots$, the image of the unit circle covers the circle $|w| < \Gamma^2((k+1)/\Gamma(k+2)/k)$.

PEN.11:001

Pennsylvania U. Dept. of Mathematics, Philadelphia.

ON THE SHEETED STRUCTURE OF COMPACT LOCALLY AFFINE SPACES, by L. Auslander. 1957, 10p. (AFOSR-TN-57-585) (AF 49(638)12) AD 136573 Unclassified

Also published in Mich. Math. Jour., v. 5: 163-168, 1958.

The following theorems are proved where M denotes an n -dimensional compact locally affine space, Γ the fundamental group of M , and $h(\Gamma)$ the holonomy group of M . I. Let Z^s denote the direct sum of the integers taken s times, and assume that Z^s is the kernel of the homomorphism of Γ onto $h(\Gamma)$, $s \geq 1$, and that $h(\Gamma)$ contains no elements of finite order; then M is a fiber bundle over a compact locally affine space whose fundamental group is $h(\Gamma)$ and the fiber is the s -dimensional

torus. II. Let Γ/Z^s be isomorphic to $h(\Gamma)$, $s \geq 1$; and assume that $h(\Gamma)$ contains elements of finite order. Then there exists a mapping $p: M \rightarrow X$, where X is a compact space, which is not a manifold, with the following properties: (1) $p^{-1}(x)$, $x \in X$, is a compact s -dimensional manifold which can be given a Riemann metric with curvature and torsion zero, and (2) the mapping p satisfies the required hypothesis for applying the Fary spectral sequence. III. Let Γ be the fundamental group of a compact locally affine space M and assume that Γ has a nontrivial radical; then there exists a mapping $p: M \rightarrow X$, where X is a compact space, not necessarily a manifold, and the preimage of each point x under p is a compact manifold with a torus as covering space. An example is given of a locally affine manifold which shows that the conclusions of theorem II are essentially the best possible. (ASTIA abstract)

PEN.11:002

[Pennsylvania U. Dept. of Mathematics, Philadelphia.]

COMPACT LOCALLY AFFINE SPACES WITH ABELIAN HOLONOMY GROUPS, by L. Auslander. [1957] 16p. (AFOSR-TN-57-645) (AF 49(638)12) AD 136631 Unclassified

This mathematical study is divided into 2 parts. The main results in Part I are formulated in the following theorems: Theorem A. Let Γ be the fundamental group of a compact locally affine space with abelian holonomy

group $h(\Gamma)$. Assume further that $h(\Gamma)$ contains no elements of finite order. Then Γ is the fundamental group of a compact solvmanifold S . Further S and R^n/Γ are homeomorphic. Theorem B. Let Γ_1 and Γ_2 be isomorphic and fundamental groups of compact locally affine spaces, both of which have abelian holonomy groups. Then R^n/Γ_1 and R^n/Γ_2 are homeomorphic. In Part II the main results are formulated as follows: Theorem C. Given $\Gamma \subset A(n)$, Γ the fundamental group of a compact solvmanifold with abelian holonomy group, there exists an n -dimensional solvable Lie group S , $S \subset A(n)$, whose component of the identity S_0 is simply connected, and such that Γ is a uniform subgroup of S . Further, (1) S is a split extension of S_0 by a finite group, and (2) there is a natural action of Γ on S_0 such that S_0/Γ^1 , where Γ^1 , acting on S_0 , and R^n/Γ are homeomorphic. It is shown that the groups Γ which can be the fundamental groups of compact locally affine spaces with abelian holonomy groups must satisfy a relation analogous to the Jacobi identity for Lie algebras.

PEN.06:023

Pennsylvania U. Dept. of Physics, Philadelphia.

STUDIES IN PHOTONUCLEAR REACTIONS. Annual rept. Oct. 15, 1957, 8p. (AFOSR-TN-57-712) (AF 18(600)472) Unclassified

A report is presented of the research completed under this contract on the following subjects: (1) Photodisintegration of deuteron; (2) Photodisintegration of europium; and (3) Performance of the new energy integrator.

PEN.06:024

Pennsylvania U. [Dept. of Physics] Philadelphia.

PHOTONEUTRON CROSS SECTIONS OF Eu^{151} AND Eu^{153} (Abstract), by B. C. Cook and K. [N.] Geller. [1958] [1]p. (AF 18(600)472) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 56, Jan. 29, 1958.

A general broadening of the width of the giant resonance in photonuclear cross sections for nonmagic nuclides is now well established. The correlations of width with nuclear deformation for spheroidal nuclei has been suggested but is as yet unconfirmed. Since it is known from coulomb excitation that the ground state of Eu^{151} is spherical while that of Eu^{153} is spheroidal, a

PEN.06:025, 026; PEN.08:008

measurement of the total γ -absorption cross section for these isotopes will yield evidence regarding the possible correlation. The yields of photoneutrons from enriched Eu^{151} and Eu^{153} have been measured from threshold (~ 8 mev) to 24 mev in 200-kev intervals using bremsstrahlung from a 25-mev betatron. The shapes of the two excitation curves are quite dissimilar. For Eu^{151} the curve is typical of curves obtained for most elements while Eu^{153} the curve is quite similar to that of Ta, an element known to have a very broad cross section. The cross sections obtained by analysis of the yield curves are presented.

PEN.06:025

Pennsylvania U. [Dept. of Physics] Philadelphia.

ANGULAR DISTRIBUTION OF PHOTOPROTONS FROM DEUTERIUM FROM 9 TO 23 MEV, by A. Whetsone and J. Halpern. [1958] [7]p. incl. illus. diagrs. refs. (Sponsored jointly by [Air Force Office of Scientific Research under AF 18(600)472] and Office of Naval Research) Unclassified

Published in Phys. Rev., v. 109: 2072-2078, Mar. 15, 1958.

Photoprotons from a deuterated paraffin target irradiated with betatron x-rays have been detected with a NaI(Tl) scintillator. The angle and energy of the proton have been measured, and the data has been fitted to

the angular distribution form $f(\theta) = (A + B \sin^2 \theta) / (1 + 2 \beta \cos \theta)$. The ratio A/B rises from a value of 0.015 ± 0.041 for the 9- to 12-mev photon group to a value of 0.133 ± 0.020 for the 20- to 23-mev group. A/B increases in a complicated way suggesting several contributions to the isotropic component. The value determined for β agrees with the calculation of v/c . A

Schiff thin-target spectrum is assumed for the incident photons, and the cross section obtained is consistent with the Marshall and Guth calculations, although the energy dependence of the data has slightly less slope than the calculated values. (Contractor's abstract)

PEN.06:026

Pennsylvania U. [Dept. of Physics] Philadelphia.

ENERGY CONTROL OF A 25-MEV BETATRON (Abstract), by K. N. Geller, J. Halpern and others. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)472] and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 169, May 1, 1958.

To obtain precise information concerning photonuclear reactions, energy stability of the bremsstrahlung tip is often required to be better than ± 10 kev over an extended period. To this end a new energy control system has been designed. Integration of the voltage induced in a small pickup coil situated at the electron donut serves as the analog of the orbit flux density. Expansion of the electron orbit occurs when this analog voltage exceeds a preselected discriminator level. For increased energy resolution a faster method of expansion using a quadrupole sector coil is employed. The x-ray pulse has a full width at half-intensity of $0.3 \mu\text{sec}$. To maintain a fixed relation between orbit flux density and the voltage analog, the latter is clamped near ground for about $1200 \mu\text{sec}$ before the field passes through zero. At this time, a zero-field trigger occurs which releases the clamp and allows the reference voltage to rise. Short term stability of better than ± 4 kev has been achieved. A drift of about 10 kev over a 10 hr interval is present. The over-all long term stability for a typical 5-wk interval is 15 kev. A preliminary calibration based on (γ, n) thresholds for D, Be^9 , Bi^{209} , Pb^{207} , Pb^{208} , Cu^{63} , and P^{31} is linear on a momentum versus "helipot" setting plot. The calibration is known to about 50 kev. The apparent thresholds for O^{16} , and B^{10} fall off this calibration line by approximately 200 kev.

PEN.08:008

Pennsylvania U. Dept. of Physics, Philadelphia.

THE THERMAL EXPANSION OF THE LITHIUM FLUORIDE LATTICE AND ITS COMPARISON TO THE LINEAR MACROSCOPIC THERMAL EXPANSION, by E. A. Abramson. June 1957, 40p. Incl. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-57-319) (AF 18(600)-561) AD 132390 Unclassified

The thermal expansion of the lithium fluoride lattice has been measured by x-ray back reflection techniques. The measurements have been carried out on both single crystal and powdered samples. Although the results of previous investigators appear to indicate that the value of the thermal expansion obtained from single crystal diffraction experiments differs from that obtained with powdered diffraction techniques, no significant difference between the single crystal and powder values could be detected in the present experiments. The previously reported difference between the values of the macroscopic linear thermal expansion and the lattice thermal expansion of the alkali halides is again observed for the case of lithium fluoride. Our value for the relative thermal lattice expansion ($\Delta d/d$) in raising the temperature from 29 to 270°C is 9.5×10^{-3} . This is 0.6×10^{-3} less than the value for the relative macroscopic thermal expansion ($\Delta L/L$) in the same temperature range, obtained by Lin at this laboratory using dilatometric methods. Several

PEN.09:008, 009; PEN.10:005, 006

explanations for this observed difference are examined, and it is concluded that, being so large, the difference can only be accounted for by some macroscopic mechanism. (Contractor's abstract)

strahlung. Measurements of the angular distribution at 6.91 mev and of peak absorption cross sections are in progress.

PEN.09:008

Pennsylvania U. Dept. of Physics, Philadelphia.

SCATTERING OF GAMMA RAYS BY A STATIC ELECTRIC FIELD, by A. M. Bernstein and A. K. Mann. [1958] [38]p. incl. diagrs. refs. (AFOSR-TN-58-83) (AF 18(600)894) AD 148131 Unclassified

Also published in Phys. Rev., v. 110: 805-814, May 15, 1958.

The absolute differential cross section of the elastic scattering of gamma rays has been measured in order to determine the contribution of the Delbrück scattering after subtraction for the known Rayleigh and nuclear Thompson scattering has been carried out. Measurements using 2.62 mev gamma rays on lead have given values of the experimental cross sections at intermediate angles which are substantially larger than the contributions expected from the other two sources. This extra contribution most probably is due to Delbrück scattering.

PEN.10:005

Pennsylvania U. Dept. of Physics, Philadelphia.

TRANSITION AMPLITUDES FOR PHOTO-MESON PRODUCTION FROM NUCLEONS AND PHOTO-DISINTEGRATION OF THE DEUTERON, by L. D. Pearlstein and A. Klein. Jan. 1957 [23]p. incl. tables. (Technical note no. 5) (AFOSR-TN-57-71) (AF 18(603)60) AD 120414 Unclassified

Also published in Phys. Rev., v. 107: 836-842, Aug. 1, 1957.

An elementary technique of general applicability is applied to the explicit construction as operators in the spin space of the particles involved, of the transition matrices for photo-production of mesons from nucleons, and photo-disintegration of the deuteron.

PEN.10:006

Pennsylvania U. Dept. of Physics, Philadelphia.

COMPLETE SET OF DISPERSION RELATIONS FOR A CLASS OF FIXED SOURCE MESON THEORIES, by R. E. Norton and A. Klein. Mar. 1957, 44p. incl. diagrs. refs. (Technical note no. 6) (AFOSR-TN-57-132) (AF 18(603)60) AD 120488 Unclassified

Also published in Phys. Rev., v. 109: 584-600, Jan. 15, 1958.

The structure of the transition matrices for all processes that can occur for a class of fixed source meson theories is studied. The model consists of scalar meson field coupled to an extended source in such a way that any finite number of quanta can be emitted or absorbed at a given time (multiple vertices), but that all interactions are restricted to be S-wave in nature. The general reaction matrix element for m incident and n emergent particles contains many terms describing sequences of independent processes, which must be removed before one obtains a proper object for studies of a dispersion theoretic nature. It is shown that the ratio of the residual matrix element to a suitable product of source functions possesses those analytic properties, as a function of the total energy of the system, which permit dispersion relations to be stated. Other than for the elastic scattering amplitude the latter make reference to values of the amplitude in a nonphysical energy region. In conjunction with a suitably generalized unitarity condition, however, the scheme, when viewed as a set of coupled integral equations, can be solved by successive approximations in terms of a number of arbitrary constants, essentially equal to the number of coupling

PEN.09:009

Pennsylvania U. [Dept. of Physics] Philadelphia.

NUCLEAR RESONANCE SCATTERING OF 7-MEV PHOTONS BY LEAD (Abstract), by K. Reibel and A. K. Mann. [1958] [1]p. [AF 18(600)894] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 174, May 1, 1958.

The cross section for nuclear resonance scattering of 6.91- and 7.14-mev gamma rays by lead have been measured. The incident radiation is produced in the reaction $F^{19}(p,\gamma)O^{16}$; at proton energies of 2.05 and 2.40 mev, each of the lines has a Doppler broadened total width of about 130 kev and the ratios of the intensities of the 7.14- and 6.91-mev radiations are approximately 4.0 and 0.25, respectively. Preliminary measurements indicate that:

(a) $\sigma_{7.1}/\sigma_{6.9} \sim 3.5$, (b) $\sigma(\theta)_{7.1} \sim 1 + \cos^2\theta$, and (c) $\sigma_{7.1} = 18 \pm 4$ mb. Assuming electric dipole transitions, as suggested by the angular distribution, the ratio of level width to level spacing, Γ/D , is found to be of order 10^{-4} , in agreement with the value obtained using brems-

PEN.10:007 - PEN.10:010

constants in the original Hamiltonian (actually one fewer). Nevertheless, it is pointed out that the scheme does not admit a unique solution, and this is illustrated physically by exhibiting an extended class of Hamiltonians which yield the same dispersion relations, but which, as a class, contain more coupling constants than make their appearance in the dispersion relations. Physically, these are connected with the occurrence of resonance scattering. (Contractor's abstract)

PEN.10:007

Pennsylvania U. [Dept. of Physics] Philadelphia.

THE MANY BODY PROBLEM IN QUANTUM FIELD THEORY, by A. Klein and C. Zemach. Mar. 1957, 35p. incl. refs. (Technical note no. 7) (AFOSR-TN-57-133) (AF 18(603)60) AD 120489 Unclassified

Also published in Phys. Rev., v. 108: 126-138, Oct. 1, 1957.

A formalism for the covariant description of scattering processes involving composite particles is derived from first principles. Its basic ingredients are the Green's functions of quantum field theory combined with a physically sound formulation of the adiabatic hypothesis. Explicit expressions are presented for various examples of nucleon-nucleus and boson-nucleus collisions. It is shown that the impulse approximation can be formulated for such problems. A general method of obtaining electromagnetic moments of nuclei, based on the scattering formalism, is also derived. The normalization condition for covariant amplitudes is discussed and its application to bound-state problems reviewed. In particular, a method of carrying out perturbation theory for the discrete spectrum is suggested. (Contractor's abstract)

PEN.10:008

Pennsylvania U. Dept. of Physics, Philadelphia.

A DERIVATION OF A COMPLETE SET OF DISPERSION RELATIONS AND AN EXAMINATION OF THEIR PHYSICAL CONTENT, by R. E. Norton. June 1957, 86p. incl. refs. (Technical note no. 8) (AFOSR-TN-57-309) (AF 18(603)60) AD 132380 Unclassified

A study is made of the structure of transition matrices for all processes that can occur for a class of fixed-source meson theories. The model consists of a scalar meson field coupled to an extended source in such a way that (1) any finite number of quanta can be emitted or absorbed at a given time, and (2) all interactions are restricted to be S-wave in nature. The ratio of the residual matrix elements to a suitable product of source functions is shown to possess analytic properties (as a function of the total energy of the system) which permit dispersion relations to be stated. With a

suitably generalized unitarity condition, the scheme when considered as a set of coupled integral equations, can be solved by successive approximations in terms of a number of arbitrary constants, essentially equal to the number of coupling constants in the original Hamiltonian. Proof is given that the scheme does not, however, admit a unique solution. The solution which contains the fewest number of arbitrary constants is the solution for the Hamiltonian whose unperturbed part has a minimum of structure. The additional solutions correspond to the more complicated Hamiltonians and exhibit a resonant behavior. The case of 2 additional theories which can be solved exactly is calculated for verification.

PEN.10:009

Pennsylvania U. Dept. of Physics, Philadelphia.

DISPERSION RELATIONS FOR THE SCATTERING OF A NON-RELATIVISTIC PARTICLE BY A CENTRAL POTENTIAL, by A. Klein and C. Zemach. Oct. 1957, 14p. (Technical note no. 9) (AFOSR-TN-57-688) (AF 18(603)60) AD 136683 Unclassified

Dispersion relations analogous to those which hold in quantum field theory are established for an alternative pair of scattering amplitudes, one of which has not been investigated hitherto. The proofs are based on a study of the Born series and of the known properties of the Green's function, as the resolvent of a self-adjoint transformation, and require only that the potential be local and satisfy certain reasonable integrability conditions. The problem of continuation of the new amplitude into the non-physical region is even more acute than usual, but is solved by means of a power series in the momentum transfer. (Contractor's abstract)

PEN.10:010

Pennsylvania U. Dept. of Physics, Philadelphia.

[THEORETICAL STUDIES IN MESON-NUCLEON INTERACTIONS AND QUANTUM ELECTRON DYNAMICS] Final rept. [1958] 1v. incl. diagrs. tables, refs. (AFOSR-TR-58-150) (AF 18(603)60) AD 265851 Unclassified

The work performed under this contract may be summarized as follows: Non-relativistic dispersion relations have been developed for general classes of fixed source meson theories. A theory of the static two-nucleon potential has been developed and compared with experimental results. A formalism for treating bound state problems in relativistic field theories and application of this theory to the problem of the photodisintegration of the deuteron are presented. Weak interactions have been studied with respect to the possible role of non-local interactions in μ meson decay. The results of these studies are described in the following publications: (1) Dispersion Relations For Fixed-Source Meson Theories, by A. Klein (item no. PEN.10:001); (2)

PEN.10:011 - PEN.10:014

Dispersion Relations For Fixed-Source Meson Theories: Effective-Range Relations, by A. Klein (item no. PEN.10:002); (3) Construction Of The Adiabatic Nuclear Potential: Formalism, by A. Klein and B. H. McCormick (item no. PEN.10:004); (4) Transition Amplitudes For Photo-production Of Mesons From Nucleons And Photodisintegration Of The Deuteron, by L. D. Pearlstein and A. Klein (item no. PEN.10:005); (5) Many-Body Problem In Quantum Field Theory, by A. Klein and C. Zemach (item no. PEN.10:007); (6) Complete Set Of Dispersion Relations For A Class Of Fixed-Source Meson Theories, by R. E. Norton and A. Klein (item no. PEN.10:006); (7) Significance Of The Redundant Solutions Of The Low-Wick Equation, by R. Norton and A. Klein (item no. PEN.10:015); (8) Phenomenological Analysis Of μ Decay, by S. Bludman and A. Klein (item no. PEN.10:013); (9) Inner Bremsstrahlung In Mu-Meson Decay, by N. Tzoar and A. Klein (item no. PEN.10:017); (10) On The Concept Of Potential In Quantum Field Theory, by A. Klein (item no. PEN.10:012); and (11) Derivation Of The Two Nucleon Potential, by A. Klein and B. H. McCormick (item no. PEN.10:011).

PEN.10:011

Pennsylvania U. [Dept. of Physics] Philadelphia.

DERIVATION OF THE TWO NUCLEON POTENTIAL, by A. Klein and B. H. McCormick. [1958] [26]p. incl. diagrs. refs. (Bound with its AFOSR-TR-58-150; AD 205851) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)60] and Atomic Energy Commission) Unclassified

Also published in Prog. Theoret. Phys. (Japan), v. 20: 876-889, Dec. 1958.

A new derivation of the two-nucleon potential proposed recently by the authors is given which avoids the ambiguous features of the scattering formalism employed previously. It is based on the reduction to a Schrödinger equation of a suitable covariant two-nucleon equation. An approximate evaluation of the fourth-order potential highlights the significant departure of the present proposals from past perturbation calculations, but represents a serious overestimate qualitatively of the additional contributions.

PEN.10:012

Pennsylvania U. [Dept. of Physics] Philadelphia.

ON THE CONCEPT OF POTENTIAL IN QUANTUM FIELD THEORY, by A. Klein. [1958] 18p. incl. refs. (Bound with its AFOSR-TR-58-150; AD 205851) (AF 18-603)60) Unclassified

Also published in Prog. Theoret. Phys. (Japan), v. 20: 257-266, Sept. 1958.

This report contains two forms of the two-nucleon potential computed to fourth order in the coupling constant from the gradient coupling of the pi-meson to the nucleon field. These are commonly referred as the Taketani-Machido-Onuma (T.M.O.) and the Brueckner Watson (B.W.) potentials. The merits of the controversy surrounding this schism are reexamined from first principles starting from the covariant equation for two-nucleons, and it is concluded that the conditions for the applicability of the method leading to the T.M.O. potential are never satisfied in practice. On the other hand, the B.W. potential, suitably altered following recent suggestions by Miyazawa and the author may well yield a suitable approximation in the low energy region.

PEN.10:013

Pennsylvania U. Dept. of Physics, Philadelphia.

PHENOMENOLOGICAL ANALYSIS OF μ DECAY, by S. Bludman and A. Klein. [1958] [4]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-603)60] and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 109: 550-553, Jan. 15, 1958.

The spectrum, asymmetry, and helicity of the electrons from μ decay are calculated from the most general form of the two-component neutrino theory with lepton-conservation. In addition to the non-local interactions considered recently by Lee and Yang, terms appearing phenomenologically as derivative couplings may occur. In particular, a spectrum that is, aside from a statistical factor, linear in momentum is possible with $p \neq 3/4$. This could be interpreted as evidence that fermions of baryonic mass are responsible for nonlocality.

PEN.10:014

Pennsylvania U. [Dept. of Physics] Philadelphia.

BORN SERIES AND DISPERSION RELATIONS IN NON-RELATIVISTIC QUANTUM THEORY (Abstract), by A. Klein and C. Zemach. [1958] [1]p. [AF 18(603)60] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29- Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 68, Jan. 29, 1958.

Potential scattering of a nonrelativistic particle is examined with the aid of the Born series for the Green's function and the scattering amplitude. For a wide class of potentials, such series are shown to converge absolutely at sufficiently high incident energies and their values are approximated by their leading terms. These and related results provide a simple mathematical basis for the derivation and extension of previously given

PEN.10:015-017; PIS.02:001

nonrelativistic dispersion formulas with less restrictive hypotheses. Dispersion relations for fixed momentum transfer and for fixed scattering angle are treated.

PEN.10:015

Pennsylvania U. Dept. of Physics, Philadelphia.

SIGNIFICANCE OF THE REDUNDANT SOLUTIONS OF THE LOW-WICK EQUATION, by R. Norton and A. Klein. Oct. 14, 1957 [5]p. incl. diagr. refs. [AF 18-(603)60] Unclassified

Published in Phys. Rev., v. 109: 991-995, Feb. 1, 1958.

The content of the Low-Wick scattering formalism is studied, using the example of a class of exactly soluble meson theories with fixed-source interaction. The theories in question describe a set of harmonic oscillators with an arbitrary distribution of frequencies, coupled to a scalar meson field by means of their total dipole moment. The Low equation for scattering of a meson is shown to possess infinitely many solutions. These are compared with the exact, explicit solution of the same problem, and it is shown that there is one-to-one correspondence between a particular choice of theory (number of oscillators and their frequencies) and a given one of the aforementioned solutions of the Low equation. A similar situation is shown to obtain for symmetric pseudoscalar theory, and it is made plausible thereby that Chew and Low have chosen the particular solution appropriate to their Hamiltonian. (Contractor's abstract)

PEN.10:016

Pennsylvania U. [Dept. of Physics] Philadelphia.

PROOF OF DISPERSION RELATIONS IN FIELD THEORY (Abstract), by R. Prange and A. Klein. [1958] [1]p. [AF 18(603)60] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 170, May 1, 1958.

Recent proofs of dispersion relations for pion-nucleon scattering employ the device of continuing the amplitude with respect to the square of the pion mass. Dispersion relations are established first for negative values of this parameter. The passage back for the physical value is then rigorously justified. We have developed an alternative method which initially proceeds by keeping part of the energy dependence fixed. In a manner formally analogous to the proof for the forward scattering of light, the amplitude is then shown to satisfy a dispersion relation in the remaining energy dependence. The relation itself is unconventional, however, in that the absorptive part

refers solely (except for one point) to the nonphysical region. In order to convert to the more usual relation, the behavior of the amplitude as a function of the hitherto unused energy dependence has been studied. So far the proof has been completed only for the limit of infinite nucleon mass.

PEN.10:017

Pennsylvania U. [Dept. of Physics] Philadelphia.

INNER BREMSSTRAHLUNG IN MU-MESON DECAY, by N. Tzoar and A. Klein. [1958] [3]p. [AF 18(603)60] Unclassified

Published in Nuovo Cimento, Series X, v. 8: 482-484, May 1, 1958.

The transition probability for decay of the μ -meson with the emission of an additional photon is computed on the basis of the most general two-component theory of the neutrino with lepton conservation. The estimated ratio of one radiative event per 10^5 decays suggests that the experiment may be feasible in the near future. (Contractor's abstract)

PIS.02:001

Pisa U. Inst. of Physiology, (Italy).

PERSISTENT PATTERNS OF WAKEFULNESS IN THE PRETRIGEMINAL MIDPONTINE PREPARATION, by C. Batini, G. Moruzzi and others. [1958] [3]p. incl. diagrs. (AFOSR-TN-58-564) (AF 61(514)1125) AD 158382 Unclassified

Also published in Science, v. 128: 30-32, July 4, 1958.

Of the two preparations (the "rostrorhombic" and the "midpontine pretrigeminal" cats, both connected to sensory receptors through the first two cranial nerves only), the former displays a permanently synchronized electroencephalogram, whereas the latter shows a clear-cut desynchronization. Thus, the critical factor is the injury or the integrity of a small amount of nervous tissue lying in the rostral part of the pons. The behavioral and electroencephalographic patterns of the "midpontine" animal do not appear to result from hypoventilation and consequent hypercapnia, as demonstrated by blood gas measurement before and after appropriate brain-stem transection. A synchronizing, or possibly sleep-inducing, influence exerted by some structure in the caudal brain stem can be tentatively envisaged.

PIT.04:001; PIT.02:012, 013

PIT.04:001

Pittsburgh U. Dept. of Physics, Pa.

STRENGTHS AND WIDTHS OF PRESSURE-BROADENED HCl INFRARED LINES (Abstract), by H. J. Babrov, G. A. Ameer, and W. M. Benesch. [1957] [1]p. (AF 18-600)986) Unclassified

Presented at Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 10-14, 1957.

Published in Symposium on Molecular Structure and Spectroscopy. Abstracts, 1957, p. 38.

As part of an investigation of the various aspects of the pressure broadening of infrared absorption lines, the authors have undertaken the measurement of the line strengths and widths of several of the P-branch lines of fundamental vibration-rotation band of HCl. The value here obtained for the band absorption coefficient, $S_{1,0}^{\circ}$, is $143 \text{ cm}^{-2} \text{ atm}^{-1}$. This is based on a line strength for the P-1 line, S_{P-1}° , of $6.60 \text{ cm}^{-2} \text{ atm}^{-1}$ at 300°K . The line width of the P-1 line when broadened by nitrogen is $\alpha_{P-1}^{\circ} = .12 \text{ cm}^{-1} \text{ atm}^{-1}$ at 300°K . One of the favorable aspects of the present method is the use of a single large absorption cell into which are introduced easily reproducible mixtures of gases under moderate pressures. The resulting lines are large and easily planimeted. The resulting equivalent widths are treated in a manner indicated by the following equation:

$$\frac{W_{\alpha}^{35} S_{\alpha}^{37}}{W_{\alpha}^{37} S_{\alpha}^{35}} = \frac{f(\beta \chi^{37})}{f(\chi^{37})}$$

where $\chi = \frac{SL}{2\pi\alpha}$, $\beta = \frac{\chi^{35}}{\chi^{37}}$, and the function $f(\chi)$ is well

known and tabulated. S is the line absorption coefficient, L is the optical path length, and α is the line half-width produced by relatively large nitrogen pressures. The superscripts refer to the two isotopic lines of HCl. To obtain a large value of β , the less abundant isotope at very low HCl pressure and high (~ one atmosphere) N_2 pressure is used in one half of the experiment, while the more abundant isotope at higher HCl pressure and low (~ 1/6 atmosphere) N_2 pressure is used in the second half. It may be noted that this method is not inherently dependent on the presence of isotopes.

and J. Kondo. Apr. 5, 1957, 63 p. incl. tables, refs. (AFOSR-TN-57-166) (AF 18(600)892) Unclassified

Also published in Phys. Rev., v. 109: 730-741, Feb. 1, 1958.

Superexchange interaction in the MnO crystal is studied by using the Heitler-London picture including overlap. Mechanisms proposed by Slater, Kramers-Anderson and Goodenough are developed on the same basis. Energy difference between the antiparallel spin state and the parallel spin state is computed numerically in the case of the simple four electron problem. (Contractor's abstract)

PIT.02:013

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

PROBLEM OF SPIN ARRANGEMENTS IN MnO AND SIMILAR ANTIFERROMAGNETS, by F. Keffer and W. O. Sullivan. [1957] [8]p. incl. diagr. refs. (AFOSR-TN-57-358) (Also bound in its AFOSR-TR-58-46; AD 228953) (AF 18(600)892) AD 132476 Unclassified

Also published in Phys. Rev., v. 108: 637-644, Nov. 1, 1957.

The magnetic dipolar energy is computed for ordering of the second kind with the four antiferromagnetic sublattices of a face-centered cube making arbitrary spin directions with respect to one another, and this energy is shown to be of the same form in the sublattice direction cosines as is the calculated powder neutron-diffraction pattern. (The dipolar energy is also calculated for ordering of the third kind and shown to lead to a spin arrangement in disagreement with powder neutron-diffraction results on βMnS .) The observed neutron patterns in MnO and αMnS agree with minimum dipolar energy, but many spin arrangements can satisfy this, and the spins are constrained only to certain regions.

Other sources of anisotropy in Mn^{++} salts are shown to be much weaker. A model is introduced in which the spins are constrained by dipolar and exchange forces to point parallel to (111) planes and constrained by the weaker anisotropy to a threefold set of easy axes within these planes. Nagamiya's small-field approximation for the field dependence of the powder susceptibility of a uniaxial antiferromagnet is extended to all values of the applied field, and a similar calculation is made for the powder susceptibility of the MnO model. Comparison with experimental data indicates that the weak within-plane anisotropy is $3 \times 10^4 \text{ ergs/cm}^3$ which is to be contrasted with the theoretical out-of-plane dipolar anisotropy of 10^7 ergs/cm^3 . A rough theory of antiferromagnetic resonance for the model seems to explain the partial paramagnetic-like absorption observed below the Néel point.

PIT.02:012

Pittsburgh U. [Sarah Mellon Scaife] Radiation Lab., Pa.

ON SUPEREXCHANGE INTERACTION, by J. Yamashita

PIT.02:014 - PIT.02:018

PIT.02:014

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

ON ELECTRONIC CURRENT IN NiO, by J. Yamashita and T. Kurosawa. [1957] [36]p. incl. tables, refs. (AFOSR-TN-57-369) (AF 18(600)892) AD 132441

Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 147, Mar. 21, 1957.

Also published in Jour. Phys. Chem. Solids, v. 5: 34-43, 1958.

A discussion on conduction mechanism by motion of an extra-electron which is tightly bound to an ion in an ionic lattice is presented. It is assumed that the wave function of the electron is localized closely around an ion and motion of the electron is so slow that the lattice polarization is induced around the electron. In this case conduction mechanism may not be well explained by the usual band theory, but it might be better to use the Heitler-London picture and to understand the current as a result of wandering motion of the electron from ion to ion. This conduction mechanism was applied and explains the electronic current which appears in the NiO crystal or the LaMnO_3 crystal.

PIT.02:015

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

BAND THEORY AND ANTIFERROMAGNETISM, by J. Yamashita and J. Kondo. [1957] 46p. refs. (AFOSR-TN-57-402) (AF 18(600)892) AD 132480

Unclassified

A band theory of antiferromagnetism is developed on the basis of the alternate band picture proposed by Slater. Applicability of a band picture to 3d electrons of the transition metal in compounds is examined (Section 2), possibility of metallic antiferromagnetism is discussed for a simplified model (Section 3), and some speculations are made about antiferromagnetism in real compounds and metals (Section 4). (Contractor's abstract)

PIT.02:016

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

STUDY OF THE WURTZITE-TYPE BINARY COMPOUNDS. II. MACROSCOPIC THEORY OF THE DISTORTION AND POLARIZATION, by F. Keffer and A. M. Portis. [1956] [34]p. incl. diagr. tables, refs.

(AFOSR-TN-57-487) (Also bound with its AFOSR-TR-58-46; AD 228953) (AF 18(600)892) AD 129820

Unclassified

Also published in Jour. Chem. Phys., v. 27: 675-682, Sept. 1957.

The slight departure of wurtzite-type binary compounds from ideal c/a ratio and ideal sublattice displacement parameter u is accounted for by the forces arising from partial polar binding. These long-range forces are calculated in terms of a postulated charge $\pm fe$ per ion and certain lattice sums which were evaluated. When balanced against the lattice piezoelectric, and dielectric constants of the crystal, the forces account for both the direction and the order of magnitude of the distortion. The compounds AlN, BeO, and ZnO are considered in detail. An experimental value of 8.5 is given for the dielectric constant of AlN, but in the absence of precise values for elastic and piezoelectric constants only an order of magnitude check of the theory can be made at this time. Some remarks are appended on the general problem of finite lattice sums in complex lattices which have dipole and/or quadrupole moments in the unit cell.

PIT.02:017

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

A NEW PROPERTY OF THE TURNSTILE WAVEGUIDE JUNCTION, by R. S. Potter and A. Sagar. [1957] 7p. incl. diagrs. (AFOSR-TN-57-598) (AF 18(600)892) AD 136584

Unclassified

Also published in Proc. Nat'l. Electronics Conf., Chicago, Ill. (Oct. 7-9, 1957), v. 13: 452-458, 1957.

New matching conditions for the turnstile waveguide junction have recently been determined from the scattering matrix unitary requirement. These matching conditions show that the junction possesses a new and useful isolation between adjacent rectangular waveguide TE_{10} modes as well as the well known and much used isolation between opposite rectangular waveguide TE_{10} modes. (Contractor's abstract)

PIT.02:018

Pittsburgh U. [Sarah Mellon Scaife Radiation Lab.] Pa.

DOUBLE REFRACTION OF AXIAL CRYSTALS. I. WURTZITE STRUCTURES (Abstract), by F. Keffer. [1957] [1]p. [AF 18(600)892]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

PIT.02:019 - PIT.02:021

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 119, Mar. 21, 1957.

The Lorentz factor, $4\pi/3$, used in the derivation of the Lorentz-Lorenz formula relating the optical index of refraction of an ionic crystal to the electronic polarizabilities of the ions, assumes (a) no overlap between neighbor ions, and (b) tetrahedral symmetry. In the absence of (b), any difference between the dipole field factors along and perpendicular to the crystal axis may lead to double refraction. Anisotropy in neighbor-ion overlap, which may also cause double refraction, should be absent in wurtzite structures, which have tetrahedral symmetry out to next-nearest neighbors. A revised Lorentz-Lorenz formulation, introducing anisotropic field factors, leads to a pair of equations for the ordinary and extraordinary indices of refraction. Using measured values of the indices one may solve these equations for the electronic polarizabilities of both types of ions. Results for ZnS, ZnO, BeO, CdS, and AgI are in good agreement with the polarizabilities estimated by Tessman, Kahn, and Shockley from self-consistent calculations on simpler ionic crystals. Polarizabilities of the metallic ions tend to be slightly larger than the TKS values, indicating electron displacement towards these ions, a displacement required by the partial covalent bonding.

PIT.02:019

Pittsburgh U. [Sarah Mellon Scaife Radiation Lab.] Pa.

DOUBLE REFRACTION OF AXIAL CRYSTALS. II. RUTILE STRUCTURES (Abstract), by B. Smilowitz and F. Keffer. [1957] [1]p. [AF 18(600)892] Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 119-120, Mar. 21, 1957.

The theory outlined above for wurtzite structures has been applied to rutile structures. Here, since the nearest neighbors of any ion do not satisfy tetrahedral symmetry, overlap effects will be expected to contribute to double refraction. These effects should be small, however, in strongly ionic crystals. The dipole field factors were calculated for a rutile structure with $c/a = 0.67$, and applied to the determination of the electronic polarizabilities of the ions in MgF_2 and SnO_2 . The polarizabilities for Mg^{++} and F^{--} agree well with those quoted by Tessman, Kahn, and Shockley. The values obtained for Sn^{4+} and O^{--} differ from the TKS values to a greater extent than Mg^{++} and F^{--} , indicating, as the electronegativity values would lead one to expect, a larger degree of overlap for SnO_2 . Other compounds will be discussed in addition to those mentioned above. We have also used

the field factors to evaluate the magnetic dipolar fields at fluorine sites in paramagnetic and antiferromagnetic MnF_2 .

PIT.02:020

Pittsburgh U. [Sarah Mellon Scaife Radiation Lab.] Pa.

PROPOSED MODEL FOR THE ANISOTROPY IN ANTI-FERROMAGNETIC MnO and αMnS (Abstract), by W. O'Sullivan and F. Keffer. [1957] [1]p. [AF 18(600)892] Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 118-119, Mar. 21, 1957.

According to Kaplan magnetic dipolar interactions in an antiferromagnetic FCC array with ordering of the second kind lead to a large anisotropy (4×10^6 ergs/cm³) aligning the spins parallel to ferromagnetic (111) planes; and recent Brookhaven neutron diffraction experiments on MnO , NiO , and αMnS confirm this alignment. This large anisotropy, however, disagrees with a much smaller anisotropy estimated by Nagamiya from the field dependence of xpowder in MnO . Our calculations of some other

(weaker) sources of anisotropy possible for Mn^{++} ions in S states suggest a model in which, in addition to Kaplan's (111) plane constraint, a much weaker anisotropy selects preferred directions in those planes. The field dependence of xpowder, as calculated from this model, agrees with experiment if the weak anisotropy is $\sim 1.9 \times 10^4$ ergs/cm³ or possibly less. Furthermore, the presence of this weak anisotropy helps explain the strong spin-resonance absorption, well below the Curie point, observed in powdered MnS and MnO .

PIT.02:021

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THE STUDY OF CRYSTAL AND MOLECULAR STRUCTURE BY NUCLEAR RESONANCE IN SINGLE CRYSTALS (Abstract), by C. Dean. 1957, 1p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)892 and National Science Foundation) Unclassified

Presented at meeting at the National Bureau of Standards, Washington, D. C., June 27, 1957.

Both in nuclear magnetic resonance and in nuclear quadrupole resonance the details of the spectrum from an individual nucleus depend on the relative strength and orientation of an externally applied magnetic field with

PIT.02:022 - PIT.02:025

respect to the internal magnetic and/or electric field at the site of that nucleus. With single crystal specimens the resonances from the atoms of one element at different unit cell sites can be distinguished. A sequence of spectra for different orientations of the crystal with respect to the external magnetic field can be analyzed to give the direction and magnitude of the internal field at the site of each nucleus of that element in the unit cell. These internal fields then constitute the basic data from which structural information is inferred with an accuracy and certainty which depends on the type of system under investigation. Specific cases will be described to illustrate different applications that have been made. The scope and limitations of these techniques will be discussed.

PIT.02:022

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

A NUCLEAR QUADRUPOLE RESONANCE AND X-RAY STUDY OF THE CRYSTAL STRUCTURE OF 1,2,4,5-TETRACHLOROBENZENE, by C. Dean, M. Pollak and others. [1958] [35]p. incl. diagrs. tables, refs. (AFOSR-TN-58-64) (Bound with its AFOSR-TR-58-46; AD 228953 (AF 18(600)892) AD 148107 Unclassified

Also published in Acta Crystallographica, v. 11: 710-718, Sept. 10, 1958.

The chlorine nuclear quadrupole resonance has been used to determine the C-Cl bond directions in a single crystal of 1,2,4,5-tetrachlorobenzene. With this data, the phases for the (OkI) structure amplitudes were determined directly and used in a Fourier projection. The results for the nuclear quadrupole resonance measurements and the two dimensional x-ray analysis agree within 1 to 2° in the bond orientations. The angle between adjacent C-Cl bonds in the molecule is $63 \pm 1^\circ$. The interpretation in terms of strained models is discussed in relation to the nuclear quadrupole resonance experiments.

PIT.02:023

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

ANISOTROPY ENERGY IN MnF_2 AT LOW TEMPERATURES, by T. Oguchi. [1958] 18p. incl. diagr. refs. (AFOSR-TN-58-99) (AF 18(600)892) AD 228953 Unclassified

Also published in Phys. Rev., v. 111: 1063-1066, Aug. 15, 1958.

The anisotropy energy in MnF_2 is calculated by a spin-wave method. The magnetic dipole interactions and the interactions of individual ions with their surrounding crystalline fields give the anisotropy energy of $-4.9 \times$

10^6 erg/cc at 0°K. The experimental value extrapolated to 0°K by Foner is -5.0×10^6 erg/cc. The temperature dependence of the anisotropy energy is obtained as $E_{\text{an}}(T)/E_{\text{an}}(0) = [M(T)/M(0)]^{2.9}$, where $E_{\text{an}}(T)$, $M(T)$ are the anisotropy energy and the magnetization of the sublattice at 0°K, respectively, and $E_{\text{an}}(0)$, $M(0)$ are the corresponding values at 0°K. (Contractor's abstract)

PIT.02:024

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

RESEARCH STUDIES ON ANTI-FERROMAGNETIC RESONANCE, PARAMAGNETIC RESONANCE IN PHOSPHORS, FOREIGN ATOMS IN SILVER HALIDES AND NUCLEAR RESONANCE, by F. Keffer, A. M. Portis and others. Final technical rept. Part 1, Sept. 1, 1953-Dec. 31, 1957. Jan. 31, 1958, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-46) (AF 18(600)892) AD 228953 Unclassified

The research performed under the contract is listed. Also included are reprints of the following papers: (1) AFOSR-TN-56-85, PIT.02:009; (2) PIT.02:011; (3) AFOSR-TN-57-358, PIT.02:013; (4) AFOSR-TN-57-487, PIT.02:016; and (5) AFOSR-TN-58-64, PIT.02:022.

PIT.02:025

Pittsburgh U. [Sarah Mellon Scaife Radiation Lab.] Pa.

A CALCULATION OF THE VALENCE BAND STRUCTURE IN BeO (Abstract), by W. O'Sullivan. 1958, 1p. (AF 18(600)892; continued by AF 49(638)323) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 231, May 1, 1958.

The ICAO approximation is applied toward a description of the valence band in BeO, in which only the closed shell $\text{Be}(1s)^2\text{O}(2p)^6$ configuration is considered. The treatment of closed shell systems, used by Löwdin in determining the cohesive energy in alkali halide crystals, is adopted for this calculation. Thus, no account is taken of the deformation of the oxygen valence electron distribution by the polarization field along the c axis of the wurtzite type crystal. The $\text{O}^{2-}(2p)$ radial function is used as calculated by Yamashita and Kojima for MgO and includes the correction for nonorthogonality of atomic orbitals centered on different lattice sites. The valence band width is found to be 18 ev and the maxima lie in the (k_x, k_y) plane rather than along the k_z axis.

PIT.05:001 - PIT.05:005

The 18 ev width represents an overestimate, a result that follows reasonably from the use of the $\text{MgO O}^{--}(2p)$ function.

PIT.05:001

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

SUPPRESSING SIDE-BAND INTERFERENCE IN SUPERREGENERATIVE rf SPECTROMETERS, by C. Dean and M. Pollak. [1958] [3]p. incl. illus. diags. (AFOSR-TN-58-280) (AF 49(638)323; continuation of AF 18(600)892) AD 228953 Unclassified

Also published in Rev. Scient. Instruments, v. 29: 630-632, July 1958.

By slowly modulating the quench frequency, the side-band responses of a superregenerative spectrometer to a nuclear resonance can be prevented from appearing in a recorded spectrum. When searching for an unsplit Zeeman component in a nuclear quadrupole spectrum, an equivalent simplification of the recorded spectrum can be obtained by slowly modulating the magnetic field. Satisfactory spectrometers and the required modulation and compensation circuits are described. (Contractor's abstract)

PIT.05:002

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

CONDUCTIVITY OF NONPOLAR CRYSTALS IN STRONG ELECTRIC FIELD. II, by J. Yamashita. [1958] [4]p. incl. table. (AFOSR-TN-58-380) (AF 49(638)323) AD 228953 Unclassified

Also published in Phys. Rev., v. 111: 1529-1532, Sept. 15, 1958.

The distribution function of the hot-electron has been investigated in germanium for the case of a small applied electric field, where both acoustical- and optical-mode scattering exists. The electron energy loss due to the interaction with the optical mode is found to be quite large, and it eliminates large parts of the quantitative discrepancy between the previous theory and experiment. (Contractor's abstract)

PIT.05:003

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THE VALENCE BAND STRUCTURE OF BeO , by W. J. O'Sullivan. May 1958, 78p. incl. diags. tables, refs. (AFOSR-TN-58-474) (AF 49(638)323) AD 158285; PB 135153 Unclassified

A determination is made of a representation of the

valence band of BeO for certain directions in the wurtzite brillouin zone (BZ) by using the tight binding approximation. Only the single configuration $\text{Be}(1s)^2\text{O}(2p)^6$ is considered in the calculation. The $\text{O}^{--}(2p)$ radial function from MgO is used to represent the oxygen-valence electron distribution in BeO . Free-ion radial functions are used for the tightly bound $\text{Be}(1s)$ valence electrons and the oxygen(2s) core electrons. Because of the spherically symmetric nature of the $\text{Be}(1s)^2$ and $\text{O}(2p)^6$ charge distributions, no effort is made to construct orthogonalized atomic orbitals nor to form symmetry functions, but the correction is made for nonorthogonality of atomic orbitals centered about different lattice sites. The character tables for irreducible representations of the wurtzite single (space, no spin) group and compatibility relations between irreducible representations of the groups at different points of the BZ are determined. It is predicted from the BeO calculation that the valence band peaks, if located at some point of reciprocal space possessing more than general symmetry, lie in the (k_x, k_y) plane; possibly at the midpoint of the BZ faces intersecting this plane. The valence band width, as determined, is 18 ev.

PIT.05:004

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

STUDY OF THE WURTZITE-TYPE BINARY COMPOUNDS. III. VALENCE BAND STRUCTURE OF BeO , by W. O'Sullivan. [1958] [5]p. incl. illus. diags. (AFOSR-TN-58-645) (AF 49(638)323) Unclassified

Also published in Jour. Chem. Phys., v. 30: 379-383, Feb. 1959.

The LCAO approximation is applied toward a description of the valence band BeO , in which only the closed shell $\text{Be}(1s)^2(2p)^6$ configuration is considered. Thus no account is taken of the deformation of the oxygen valence electron distribution by the polarization field along the c axis of the wurtzite-type crystal. The problem is solved along several lines of symmetry in the hexagonal brillouin zone. We find a band width of 18 ev with a depth of approximately 7 ev. (Contractor's abstract)

PIT.05:005

Pittsburgh U. [Sarah Mellon Scaife] Radiation Lab., Pa.

FEEDBACK COHERENCE CONTROL FOR SUPER-REGENERATIVE SPECTROMETERS, by C. Dean. [1958] [1]p. incl. diagr. (AFOSR-TN-58-661) (AF 49(638)323) AD 228953 Unclassified

Also published in Rev. Scient. Instruments, v. 29: 1047, Nov. 1958.

PIT.05:006 - PIT.05:009

One disadvantage of a super-regenerative spectrometer is the need to adjust its quench rate (pulse repetition rate) frequently during searches through wide bands of radio-frequencies. This is done to restore the coherence and thus the gain of the spectrometer to a convenient level. However by stabilizing the gain through a feedback control of the quench rate it is possible to considerably broaden the rf bands that can be covered without manual readjustment. The feedback signal can be developed by selecting and rectifying a band of the noise from the audio-frequency output which does not contain an appreciable amount of the nuclear resonance signals. This noise may originate in the tuned circuit or in the oscillator tube. In any event the detected noise which is found in the audio output appears to have been amplified with the same gain as the nuclear resonance signals, and a feedback signal proportional to its amplitude furnishes a suitable control signal. A 30- to 45-mc self-quenched super-regenerative spectrometer incorporating this principle is described.

PIT.05:006

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

ON THE LOW TEMPERATURE OPTICAL ABSORPTION OF $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ AND $\text{CoBr}_2 \cdot 6\text{H}_2\text{O}$, by R. Pappalardo. [1958] 52p. incl. tables, diagrs. refs. (AFOSR-TN-58-681) (AF 49(638)323) AD 162213 Unclassified

Also published in Philosophical Mag. v. 4: 219-242, Feb. 1959.

The optical absorption of crystals of $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ and $\text{CoBr}_2 \cdot 6\text{H}_2\text{O}$ was studied at room temperature, 90°K and 20°K. Some peculiarities in these spectra are reported and discussed. A tentative assignment of the observed transitions to levels predicted in terms of crystal field theory is made, obtaining a satisfactory agreement if an appropriate set of parameters is used.

PIT.05:007

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THEORY OF THE NUCLEAR MAGNETIC RESONANCE SHIFT IN PARAMAGNETIC CRYSTALS, by F. Keifer, T. Oguchi and others. [1958] 36p. incl. refs. (AFOSR-TN-58-947) (AF 49(638)323) AD 205100 Unclassified

Also published in Phys. Rev., v. 115: 1553-1561, Sept. 15, 1959.

A theoretical study is made of the shift of the F^{19} nuclear resonance in paramagnetic and antiferromagnetic MnF_2 which has been observed by Shulman and Jaccarino. The problem is reduced to that of a single Mn-F pair. A net hyperfine interaction is shown to arise from overlap effects in the ground-state ionic configura-

tion $(3d)^5(2s)^2(2p)^6$ and from overlap and transfer effects to the configurations $(3d)^6(2s)(2p)^6$ and $(3d)^6(2s)^2(2p)^5$. These three configurations are equivalent to a single configuration involving bonding-type molecular orbitals. The results are in reasonable agreement with the experiment, the theoretical isotropic shift being slightly too small and the theoretical anisotropic shift (small nondipolar part) being slightly too large. A re-appraisal is made of Tinkham's data on paramagnetic resonance Mn^{++} impurities in ZnF_2 , which Bleaney has shown to be closely related to the Shulman-Jaccarino data. It is found that there is no need to include, as did Tinkham, a large fraction of fluorine 3s and 3p functions into the bond. (Contractor's abstract)

PIT.05:008

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

DIPOLE LATTICE SUMS FOR A RUTILE STRUCTURE, by B. Smilowitz. [1958] [8]p. incl. diagr. tables. (AFOSR-TN-58-948) (AF 49(638)323) AD 261878 Unclassified

The dipole sums for a rutile crystal lattice with $c/a = 0.67$ and u parameter of 0.31 have been calculated using the Kornfeld method. Physically, the dipole sums, $D_{ik}^{\alpha\beta}$, correspond to the α component of the field at a site in the i sublattice due to the unit polarization of the k sublattice in the β direction in a Lorentz sphere. The values of the dipole sums are presented in tabular form.

PIT.05:009

Pittsburgh U. [Sarah Mellon Scaife Radiation Lab.] Pa.

TECHNIQUES OF NMR ACOUSTIC ABSORPTION (Abstract), by M. Menes and D. I. Bolef. [1958] [1]p. [AF 49(638)323] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 144, Mar. 27, 1958.

The technique used in observing nuclear magnetic resonance acoustic absorption is a combination of conventional NMR technique with the composite resonator technique used in ultrasonic measurement. The composite resonator consists of the sample, which has been ground and polished to have flat and parallel faces, to which has been cemented a quartz transducer crystal. This composite resonator is coupled through an impedance matching and inverting network to a Pound-Watkins oscillator. This is followed by conventional synchronous detection equipment. At present the technique has been successful only in materials having small acoustic damping, and for nuclei

PIT.05:010; PLA.01:001;
PLA.02:001-003

having fairly strong quadrupole coupling to the lattice. A static quadrupole interaction is, however, not necessary. Under the test conditions, with a sample size of the order of a cubic centimeter, a sensitivity comparable to conventional NMR has been obtained.

PIT.05:010

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THE GENERALIZED OVERHAUSER EFFECT AND ITS APPLICATION TO FERRO- AND ANTIFERROMAGNETISM (Abstract), by T. Oguchi and F. Keffer. 1958, 1p. (AF 49(638)323) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 193, May 1, 1958.

The theory of the Overhauser effect may be formulated from general statistical-mechanical arguments, indicating that a forced statistical redistribution may be made to occur in any sub-system whose principal contact with a heat bath is indirectly routed through some other statistically distributed system. In particular we consider Overhauser nuclear polarization in ferro- and antiferromagnets. Here the main route of nuclear relaxation will generally be via the excitation and/or absorption of spin-wave quanta. At low temperatures multiple spin-wave processes should predominate over processes involving phonons. In order to conserve energy, at least one spin wave must be annihilated if a spin wave is created; this means that the nuclear relaxation rate depends strongly on the number of spin waves present. By resonance excitation of a large number, n_0 , of $k = 0$ spin waves, with $n_0 \gg \sum_k n_k + \sum_k n_k$, (the number of thermally excited spin waves), we may force the nuclei to relax primarily to the $k = 0$ spectrum. We show that the resultant nuclear polarization is proportional to $\exp(-2\mu_N H S \hbar \omega_0 / kT)$, where ω_0 is the resonance frequency and S is the power saturation factor.

PLA.01:001

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

PASSIVE DETECTION OF MOVING BODIES IN THE UPPER ATMOSPHERE (Unclassified title), by D. G. Van Ornum. [1958] 98p. incl. illus. diagrs. tables, refs. (Technical note no. GRL-TR-11) (AFOSR-TN-58-129) (AF 49(638)11) AD 152156 Confidential

PLA.02:001

[Plasmadyne Corp.] Giannini Research Lab., Santa Ana, Calif.

THE PLASMA JET AND ITS APPLICATION, by G. M. Giannini. Aug. 2, 1957, 1v. incl. illus. diagrs. (AFOSR-TN-57-520) (AF 49(638)54) AD 136505 Unclassified

Also published in Vistas in Astronautics, v. 1: 176-188, 1957.

Discussion of the physical principles of a plasma jet and the methods to create this phenomenon are presented. With such a jet, temperatures of over 5,000°K are possible. Applications are presented for the machining of a refractory metal or ceramics, and the possibility of fusing highly refractory materials is suggested. The study of magnetohydrodynamics and the natural fusion of the stars is also discussed.

PLA.02:002

[Plasmadyne Corp.] Giannini Research Lab., Santa Ana, Calif.

PROPULSIVE PROPERTIES OF HIGH INTENSITY PLASMA JETS, by A. C. Ducati and G. L. Cann. Feb. 21, 1958, 138p. incl. illus. diagrs. tables. (Rept. no. GRL-TR-9) (AFOSR-TN-57-748) (AF 49(638)54) AD 136736 Unclassified

A continuously operating plasma generator has been developed, and experimental investigations of high intensity ionic propulsive jets have been conducted. A primary investigation of the propulsive properties indicated that specific impulses of 200 and 500 could easily be obtained for argon and helium, respectively, as a result of the direct transfer of electrical energy to the gas. Electrode and nozzle configuration was found to have a definite effect on the ratio of internal energy in the gas to ionization energy at the front exit area. Practically all of the energy in the form of nonequilibrium ionization can be assumed to be transferred to the random particle motion and direct kinetic energy of the gas. The radiated energy is to some extent included in the energy absorbed by the cooling system. The radiation measured externally to the generator was found to be approximately 5% of the input electrical energy. A limited number of mixing experiments have been performed. (Contractor's abstract)

PLA.02:003

[Plasmadyne Corp.] Giannini Research Lab., Santa Ana, Calif.

ENERGY CONTENT AND IONIZATION LEVEL IN AN INERT GAS JET HEATED BY A HIGH INTENSITY ARC, by G. L. Cann and A. C. Ducati. [1957] 21p. incl. illus. diagrs. tables. (AFOSR-TN-57-748a) (AF 49(638)54) Unclassified

PLA.02:004 - PLA.02:006

Also published in Jour. Fluid Mech., v. 4: 529-537, Sept. 1958.

Argon has been passed through an arc and ejected as a jet through an orifice in one of the electrodes. Measurements were made to determine the total gas enthalpy and the proportion of the enthalpy in directed kinetic energy, random particle motion, and ionization energy. From these measurements it is postulated that the gas is initially in a non-equilibrium state on leaving the arc, but approaches equilibrium relatively quickly when confined to a constant diameter jet outside of the arc. The gas equilibrium temperature range in these experiments varies from 5,000 to 15,000°K. (Contractor's abstract)

PLA.02:004

[Plasmadyne Corp.] Giannini Research Lab., Santa Ana, Calif.

EXPERIMENTAL STUDIES ON THE THRUST FROM A CONTINUOUS PLASMA JET, by G. [L.] Camm, A. [C.] Ducati, and V. Blackman. [Dec. 1957] 11p. incl. illus. diagrs. (Rept. no. GRL-S-1) (AF 49(638)54) Unclassified

Also published in Proc. Symposium on Advanced Propulsion Systems, Los Angeles, Calif. (Dec. 11-13, 1957), N. Y., Pergamon Press, v. 2: 33-41, 1959.

An experimental study of the thrust characteristics of a continuous, high-pressure, electrically heated jet has been carried out. Argon and helium were used as the working fluid. Equilibrium stagnation temperatures for the two gases varied from 5000 to 15,000°K with exit pressures of one atmosphere in all cases. At these temperatures real gas effects can become important in the analysis of the experiments. For instance, the measurements indicated a degree of ionization between about 0.5 and 15%, depending on the time available for the gas to reach thermodynamic equilibrium. The power input in the gas was measured directly and the fraction of this power in random motion of the particles (temperature), directed motion (thrust), and ionization was determined as a function of gas mass flow rate and chamber pressure. Original measured values of specific impulse were low by a factor of two or three when compared with expected values using real gas thermodynamics. When elongated nozzles were used to confine the jet, the values of the specific impulse were much larger and, within experimental error, equal to the calculated value. This behavior originally observed is attributed to the extreme thermal non-equilibrium which existed in the jet as it issued from the orifice. With the final configuration, specific impulses as high as 600 sec have been obtained and it is believed that values as high as 1000 sec can readily be produced with helium. (Contractor's abstract)

PLA.02:005

[Plasmadyne Corp.] Giannini Research Lab., Santa Ana, Calif.

EXPERIMENTAL STUDIES ON PLASMA JET PROPULSION, by D. F. Howard. [1958] 20p. incl. illus. diagrs. table. (Rept. no. GRL-S-3) (AFOSR-TN-58-605) (AF 49(638)54) Unclassified

Presented at Second Annual AFOSR Astronautics Symposium, Denver, Colo., Apr. 1958.

Also published in Vistas in Astronautics, v. 2: 95-103, 1959.

Experiments have been run to determine the nature and magnitude of the thrust obtainable from plasma jet propulsors. The plasma jet is produced by an electric thrust device consisting of a chamber with a cylindrical electrode at the back and an annular electrode at the front. A dc power supply establishes a potential and maintains an arc between them. Working gas is heated and ionized passing through the arc and out of the orifice at high velocity. Consequently appreciable thrust is obtained. Addition of a nozzle produces a better distribution of energy in the jet. Detailed analysis revealed the following: (1) power absorbed in cooling the electrodes is 25 to 40% of total input; (2) power loss from radiation is not greater than 5% of total input; (3) power specifically concentrated in gas kinetic motion is 5 to 15%; and (4) the remaining 50% power is apparently stored in ionization of the gas. Results show that electric arc plasma generators yield sustained, high specific impulses. However, due to the thrust-to-weight ratio, the chief practical application of plasma rockets will be for certain space missions originating and terminating at satellites where the ratio can be < 1.

PLA.02:006

Plasmadyne Corp. Giannini Research Lab., Santa Ana, Calif.

RESEARCH IN HIGH INTENSITY IONIC JETS (Abstract), by A. C. Ducati. [1958] [2p. (Bound with its AFOSR-TR-58-125; AD 162274) (AF 49(638)54) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The propulsive and related properties of high intensity plasma jets have been investigated. A primary investigation indicates that specific impulses of 200 and 500 are obtainable for Ar and He, respectively, as a result of the direct transfer of electrical energy to gas. Electron and nozzle configuration has a definite effect on the ratio of internal energy in the gas to ionization energy at the front exit area. A configuration has been developed that transfers most of the non-equilibrium

PLA.03:001-003; PLA.04:001;
PLA.05:001

ionization energy into random particle motion and direct kinetic energy of the gas. To increase thrust high power plasma heads (1000 kw and over) have been designed. These employ radical departures from certain design features of the simple conventional heads.

fusion reactors as power sources for electric thrust devices. The question of the maximum energy that can be expected from certain fuels as well as the problem of the energy extraction have been considered.

PLA.03:001

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATION OF ELECTRICAL POWER SOURCES FOR ELECTRIC THRUST DEVICES. MORPHOLOGY, by E. J. Hellund. Sept. 3, 1958, 32p. (Technical note no. E-TN088-332) (AFOSR-TN-58-790) (AF 49(638)332) AD 202223 Unclassified

A survey and classification has been made of various types of power sources which might possibly be used in conjunction with propulsion systems for space vehicles. Codification of these types has been systematically developed with the objective in mind of providing a convenient classification by means of which a rapid evaluation of any possible new power systems and propulsion systems can be made and in order to obtain an unambiguous upper limit to the performance of these systems.

PLA.03:002

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATION OF ELECTRICAL POWER SOURCES FOR ELECTRIC THRUST DEVICES. BIBLIOGRAPHY, by H. Fife. Sept. 3, 1958 [40]p. incl. diagr. table, refs. (Technical note no. E-2TN098-332) (AFOSR-TN-58-791) (AF 49(638)332) AD 202224 Unclassified

A bibliography has been prepared of the various electric power sources for electric thrust devices. The classification of the references has been carried out in terms of the location of the source, i.e. internal or external power source, and in terms of the nature of the source as either waste conversion or direct storage of energy.

PLA.03:003

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

ELEMENTARY CONSIDERATIONS OF THE DIRECT CONVERSION OF THERMONUCLEAR ENERGY TO ELECTRICAL ENERGY, by A. C. Ducati. Sept. 1, 1958, 14p. incl. diagrs. (Technical note no. E-3TN098-332) (AFOSR-TN-58-792) (AF 49(638)332) AD 202225 Unclassified

A feasibility study has been made of the use of controlled

PLA.04:001

[Plasmadyne Corp.] Giannini Research Lab., Santa Ana, Calif.

A COMPARISON OF TWO APPROACHES TO AN ELECTRIC PROPULSION SYSTEM, by V. Blackman. [1958] [30]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)332, AF 49(638)334, and AF 49(638)335, and Wright Air Development Center under AF 33(616)5709) Unclassified

Presented at First Internat'l. Congress for the Aeronautical Sciences, Madrid (Spain), Sept. 8-13, 1958.

Also published in Advances in Aeronaut. Sciences, v. 2: 1111-1123, 1959.

Considerable experimental work has been conducted recently on the production of high velocity matter. In the course of this work, results have been obtained which may be of significance to those interested in the possibility of very high specific impulse thrust devices. A brief review is presented of two electrical systems for obtaining high velocity directed mass motion of plasmas ("thermal-plasma" and "magneto-plasma" systems). In thermal-plasma systems, the enthalpy of a gas is increased by conversion of electrical energy into random particle energy by means of internal ohmic heating. In magneto-plasma systems, plasma is accelerated by the interaction of currents in a gas with magnetic fields produced by currents in fixed external conductors. Experiments are described employing examples of each system.

PLA.05:001

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

THE "PUNCH" METHOD OF COMPRESSING, HEATING AND CONFINING OF A PLASMA, by H. G. Loos. Dec. 1958, 25p. incl. diagr. refs. (Rept. no. T-1TN128-335) (AFOSR-TN-58-1130) (AF 49(638)335) AD 207975; PB 139488 Unclassified

A method of compression, heating and confinement of a plasma by means of a suddenly applied magnetic field of external origin is explored. The basic cylindrical configuration does not show any instabilities in the hydrodynamic approximation. The no. of ions (N_i) per unit length along the tube is shown to be related to the amount of separation between plasma and field that is achieved in times small compared with the decay time of the field. Furthermore, N_i determines how many large angle

PLA.05:002; POL.01:016-018

collisions an ion will undergo with other ions during the decay time. Order of magnitude calculations have been made of the energy required for heating by isentropic compression and of the energy and voltage required for shock heating. (Contractor's abstract)

PLA.05:002

Plasmadyne Corp. Giannini Research Lab., Santa Ana, Calif.

ACCELERATION AND CHANNELING OF PLASMA JETS BY MAGNETIC FIELDS (Abstract), by V. Blackman. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274) (AF 49(638)335) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

Previous experiments at the Giannini Research Lab. with the continuous arc-type plasma source as a thrust device have resulted in specific impulses up to 600 secs with helium as a working fluid. This value can be increased by a factor of two or three, but beyond this the practically attainable specific impulse of an arc jet is limited by rapidly increasing electrode erosion with increasing gas enthalpies. Likewise, the channeling of the very hot plasma by mechanical walls (conventional expansion nozzle) also becomes increasingly difficult. In order to increase the specific impulse by a large amount over the values already produced, i.e., to values above 3000 secs, one promising approach would be to accomplish both the acceleration and the channeling of the plasma by means of electromagnetic fields. Experimental work has been initiated on the creation and acceleration of plasmas by electromagnetic fields. An experimental geometry which has already been studied extensively is a gas-filled cylindrical pyrex vessel centrally girthed by a single-turn coil. A surge of current passed through the coil by the discharge of a low-inductance capacitor bank gives rise to a rapidly varying magnetic field, which in turn induces an electrodeless discharge in the gas. Ohmic heating of the resulting plasma and magnetomotive interaction between the eddy currents and the electromagnetic field transfer energy and some axial momentum to the gas. Thus, high Mach number shock waves are produced which travel along the tube away from the coil. The luminous front associated with these shock waves has been observed by high-speed photographic methods (rotating mirror camera). Exploratory experiments on the channeling effect of axially symmetric magnetic fields on a plasma jet were also undertaken. In these experiments 4000 joules of energy from a capacitor bank were discharged through a single-turn coil coaxially mounted with respect to the plasma jet. Attempts are being made to observe the resulting flow distortion effects by means of a high-speed drum camera. The experimental apparatus and data are discussed. In addition, a brief comparison between two types of plasma propulsors is presented.

POL.01:016

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

RESEARCH ON THE ELECTROCHEMICAL BEHAVIOR OF POLYCRYSTALLINE SILVER, by G. Poli. Dec. 1956 [17]p. incl. diagrs. refs. (Technical note no. 9) (AFOSR-TN-57-45) (AF 61(514)733-C) AD 115083 Unclassified

Also published in Rend. Ist. Lombardo Sci. e Lett., v. 91: 257-270, 1957.

The anodic and cathodic behavior of silver in perchlorate, nitrate and sulphamate solutions has been investigated by means of oscillographic recordings of the voltage-time curves, for very short rectangular current pulses. The influence of the anion, of the silver salt concentration and of the free acid content on the "maxima" and on the initial polarization capacities has been investigated and discussed. The activating influence of the sulphamate, nitrate and hydrogen ions has been confirmed. One explains the silver overvoltage as depending on crystallization processes.

POL.01:017

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

RESEARCH ON THE ELECTROCHEMICAL BEHAVIOR OF METALLIC SINGLE CRYSTALS, by R. Piontelli, U. Bertocci and others. Feb. 1957, 8p. incl. diagr. refs. (Technical note no. 10) (AFOSR-TN-57-218) (AF 61(514)733-C) AD 126516 Unclassified

A complete technique for investigating the electrochemical behavior of metallic single crystals has been developed, including: (a) preparation (by a modified Bridgman method) of single crystals; (b) orientation; cutting (by chemical and electrochemical method avoiding stresses); electropolishing; surface finishing; and (c) overvoltage measurements in suitable cells.

POL.01:018

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

[ASPECTS AND PROBLEMS OF ELECTROCHEMISTRY OF METALS IN ONE DECADE OF STUDY AND RESEARCH] Aspetti e problemi dell'elettrochimica dei metalli in un decennio di studi e ricerche, by R. Piontelli. [1957] [20]p. incl. illus. diagrs. table, refs. [AF 61(514)733-C] Unclassified

Published in Metall. Ital., v. 49: 69-88, Feb. 1957.

A review is presented of the results of the studies

POL.01:019 - POL.01:023

conducted by the author and his collaborators in the past decade concerning various aspects and problems of electrochemistry of metals from both the theoretical and applied viewpoints. (Contractor's abstract, modified)

POL.01:019

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

ELECTROCHEMISTRY OF METALLIC SINGLE CRYSTALS. I. EXCHANGE OVERVOLTAGES ON SILVER AND COPPER, by R. Piontelli, G. Poli and L. Paganini. [1957] [2]p. incl. diagrs. (AF 61(514)733-C)

Unclassified

Published in Nuovo Cimento, Series X, v. 5: 1018-1019, Apr. 1, 1957.

The anisotropy of overvoltage effects have been investigated for single and polycrystalline samples by means of pulse technique. Electrode voltages of Ag in AgClO_4 solution are found to be identical for (111) and (100) planes as well as for polycrystalline samples. In AgCN solution Ag voltages are found to be all different. The Cu samples in both chlorate and sulfate solutions show different overvoltages for the various planes. Tafel's law is observed not to hold in these cases.

POL.01:020

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

[STUDIES OF THE ELECTROCHEMICAL BEHAVIOR OF METALLIC MONOCRYSTALS. NOTE I] Ricerche sul comportamento elettrochimico di monocristalli metallici. Nota I, by R. Piontelli, U. Bertocci and others. [1957] [8]p. incl. illus. diagr. refs. (AF 61(514)733-C)

Unclassified

Published in Rend. Ist. Lomb. Sci. e Lett., v. 91: 347-354, 1957.

A complete technique for investigating the electrochemical behavior of metallic single crystals has been realized, including: (a) preparation (by a modified Bridgman method) of single crystals; (b) orientation; cutting (by chemical and electrochemical method avoiding stresses); electropolishing; surface finishing; and (c) overvoltage measurements in suitable cells.

POL.01:021

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

[STUDIES OF THE ELECTROCHEMICAL BEHAVIOR

OF METALLIC MONOCRYSTALS. NOTE II] Ricerche sul comportamento elettrochimico dei monocristalli metallici. Nota II, by R. Piontelli, G. Poli and L. Paganini. [1957] [16]p. incl. illus. diagrs. (AF 61(514)733-C)

Unclassified

Published in Rend. Ist. Lomb. Sci. e Lett., v. 91: 355-370, 1957.

Anodic and cathodic overvoltages of Cu and Ag single crystals electrodes (active surface oriented following (111) and (100)) have been investigated at 25°C with different solutions and cd. The structural changes involved have been studied by electron diffraction, and by micrography.

POL.01:022

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

[STUDIES OF THE ELECTROCHEMICAL BEHAVIOR OF METALLIC MONOCRYSTALS. NOTE III] Ricerche sul comportamento elettrochimico dei monocristalli metallici. Nota III, by R. Piontelli, U. Bertocci, and C. Tamplenizza. [1957] [8]p. incl. diagrs. table. (AF 61(514)733-C)

Unclassified

Published in Rend. Ist. Lomb. Sci. e Lett., v. 91: 378-385, 1957.

The hydrogen overvoltages, in H_2SO_4 0.1 M. at 25, 40, 55°C, on electrodes of Cu single crystals, in the shape of disks, whose active surface was oriented following (111), (110), (100), and on Cu polycrystalline electrodes have been investigated. Tafel law holds true. The parameters are coincident for all of the investigated electrodes.

POL.01:023

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

[STUDIES OF THE ELECTROCHEMICAL BEHAVIOR OF THALLIUM] Ricerche sul comportamento elettrochimico del tallio, by U. Bertocci and S. Ticozzi. [1957] [11]p. incl. diagrs. table. (AF 61(514)733-C)

Unclassified

Published in Rend. Ist. Lomb. Sci. e Lett., v. 91: 386-396, 1957.

The anodic and cathodic Tl overvoltages at 25° and 40° were measured in the following solutions: TlNO_3 0.25M at pH 6.3 and 1.4; TlClO_4 0.25M at pH 4.5 and 1.75; TlOH 0.25 M. The values of i_0 - amp/sq m decrease in the order NO_3^- , ClO_4^- , OH^- . The results confirm

POL.01:024 - POL.01:027

the normal behavior of Tl^+ in $TlOH$ solutions not previously investigated. The exiguity of overvoltages in aqueous solutions, which has been confirmed, probably is bound to the kinetics of crystal growth and solution phenomena.

POL.01:024

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

[STUDY OF THE SURFACE STATE OF ZINC MONO-CRYSTALS] Studio sullo stato superficiale di monocristalli di zinco, by B. Rivolta. [1957] [6]p. Incl. illus. (AF 61(514)733-C) Unclassified

Published in Rend. Ist. Lomb. Sci. e Lett., v. 91: 280-285, 1957.

The structure of the surface of Zn monocrystals, oriented according to (001) and (110) planes and electropolished, was investigated by means of an electronic diffractor ($\lambda = 0.0536\text{\AA}$) and by grazing incidence. The surface microgeometry was studied by the method of polystyrene replicas. The difference between the behavior of the planes examined was evident. Various methods of electropolishing were examined. The better results, revealing good diffraction images (Kikuchi lines) without ring of polycrystals, appeared with $HClO_4$ and $EtOH$ electropolishing.

POL.01:025

Politecnico di Milano. [Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia] (Italy).

ELECTROCHEMICAL BEHAVIOR OF NICKEL, by G. Serravalle. Dec. 1957, 29p. Incl. diagrs. tables. (Technical note no. 11) (AFOSR-TN-58-237) (AF 61(514)733-C) Unclassified

The cathodic and anodic electrochemical behavior, the passivation phenomena and the passivity conditions of Ni in aqueous solutions of various nickel salts at different pH values, temperatures, and current densities have been investigated. Cathode overvoltages were measured at temperatures from 25 to 65°C and pH from 1.5 to 4.8. The electrode voltage has been found to depend on the current density as given by the Tafel relationship. The slope of the Tafel curves depend on temperature variations, but the effect of change of pH was slight. The current efficiency is found to increase with temperature for sulfate solutions and to a smaller extent for chloride and mixed sulfate-chloride solutions. The anodic behavior for carefully prepared electrodes of very pure Ni showed that hysteresis effects were small and no evidence was found of an ohmic contribution to the overvoltage.

POL.01:026

Politecnico di Milano. [Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia] (Italy).

ELECTROCHEMICAL BEHAVIOR OF POLYCRYSTALLINE AND SINGLE CRYSTAL LEAD, by G. Poli. Dec. 1957 [15]p. Incl. diagrs. refs. (Technical note no. 12) (AFOSR-TN-58-238) (AF 61(514)733-C) AD 154140; PB 135494 Unclassified

The anodic and cathodic behavior of polycrystalline and single crystal samples of lead have been investigated in sulphamate, perchlorate and fluoborate solutions. The single crystals have been prepared by a modified Bridgeman method. The overvoltages were measured at 25°C by using a current-pulse direct method. Overvoltages were found to be very small and lower on the (100) and (110) planes than on the (111) plane on both the anode and cathode. The electrode voltage maxima were higher and the rate of change with current density was higher for the (111) plane than the others.

POL.01:027

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

RESEARCH ON ANODIC AND CATHODIC BEHAVIOR OF METALS, by R. Piontelli. Final rept. May 1958, 27p. Incl. refs. (AFOSR-TR-58-97) (AF 61(514)733-C) AD 162165 Unclassified

The measurement of electrode overvoltages of metals in solutions and fused salts was studied. The following were investigated: (1) structural characteristic of electrode material; (2) cell design with particular regard to current distribution on electrode surface, systematic errors involved by tensiometric devices, and elimination of concentration polarization; (3) contamination sources; and (4) choice of the electrical supply conditions and voltage measurement apparatus and practice. Results are discussed concerning the anode and cathode overvoltages of polycrystalline Au, Ag, Cu, Sn, Pb, Ti, Zn, Cd, In, Ni, Mg, Tl, and Fe. Thermodynamic, kinetic, and structural aspects are taken into account in the discussions on aspects of the metal electrode behavior. The anion influence on the kinetics of ionic exchange processes was considered. A glossary is proposed in order to attain sufficient order and agreement on general concepts and definitions in the study of passivation and passivity. The eventual anisotropy in the overvoltages of electrodes whose working surface corresponds to a well defined crystallographic orientation was determined. Systematic work was conducted on the electrode behavior of metals in fused salts, especially of Al in cryolite-alumina baths.

POL. 01:028, 029; POT. 01:001-003

POL.01:028

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

[STUDIES OF THE ANODIC BEHAVIOR OF TITANIUM. NOTE I. DETERMINATION OF ANODIC TENSIONS] Ricerche sul comportamento anodico del titanio. Nota I - Determinazioni di tensioni anodiche, by B. Rivolta. [1958] [8]p. incl. diagrs. tables, refs. (AF 61(514)733-C) Unclassified

Published in Metall. Ital., v. 50: 173-180, May 1958.

Studies are being made on the anodic behavior of titanium in various solutions, HCl, NaCl, H_3BO_3 , KOH, Na_2S , NaF, $HClO_4$, all 0.5 normal, investigating the effect of the density of the current and of the temperature. For solutions of NaF, the effect of acidity is investigated in addition with HF, HCl, and H_2SO_4 . In all cases except the fluoride solutions, the passivity of the electrode with formation of protective surface layers is being confirmed. (Contractor's abstract)

POL.01:029

Politecnico di Milano. Laboratorio di Elettrochimica, Chimica Fisica, e Metallurgia (Italy).

[STUDIES OF THE ANODIC BEHAVIOR OF TITANIUM. NOTE II - STUDIES OF THE CHARACTERISTICS OF THE PASSIVITY LAYERS FORMED ON TITANIUM FOLLOWING ANODIC TREATMENTS] Ricerche sul comportamento anodico del titanio. Nota II - Studio delle caratteristiche degli strati passivanti formati sul Ti in seguito a trattamenti anodici, by B. Rivolta. [1958] [8]p. incl. illus. tables. (AF 61(514)733-C) Unclassified

Published in Metall. Ital., v. 50: 255-262, July 1958.

The characteristics of the passivity strata formed on the surface of titanium as a result of anodic treatments produced at 25°, 50°, and 65°C in various electrolytes were studied by means of electronic diffraction and the metallographic microscope. (Contractor's abstract)

POT.01:001

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

TRANSONIC FLOWS AROUND SYMMETRIC AIRFOILS WITH DETACHED SHOCK WAVE, by S. Nocilla. Apr. 24, 1957 [27]p. incl. diagrs. table. (Technical note no. 1) (AFOSR-TN-57-493) (AF 61(514)1124) AD 136483 Unclassified

By the use of suitable singular functions fulfilling the equation of Tomotika and Tomada (Quart. Appl. Math., v. 9: 129, 1951) utilized as stream functions, a process is developed to construct motion fields around symmetrical wing profiles, with Mach numbers a little higher than one. The theoretical analysis is followed by a numerical calculation of a particular profile and the flow around it; a comparison is then made with the corresponding results relating to the case in which $M = 1$. On the basis of the statement of the problem, the conditions on the shock polar are fulfilled with a certain error which is explained. The solution obtained is not an exact solution in the strict sense, but it is the rigorous solution of a very similar problem, in which the flow upstream of the shock wave is not perfectly uniform but slightly distorted by these conditions.

POT.01:002

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

ON THE DISSOCIATION RATE OF A DIATOMIC GAS, by G. Jarre. July 25, 1957, 12p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-57-528) (AF 61(514)1124) AD 136513 Unclassified

A discussion is presented of a reaction rate formula which is applicable in current studies on hypersonic flow of diatomic gases. The rate of a reaction of the type, $X_2 \rightleftharpoons 2X$, is taken as the difference between the rate of the unimolecular dissociation and the rate of bimolecular recombination, $R = \bar{k}n_{X_2} - \bar{k}n_X^2$ in molecules X_2/cm^3 -sec, where $\bar{k}(sec^{-1})$ and $\bar{k}(cm^3/mol$ -sec) are the reaction constants and n_i the partial densities (mol/cm^3). The activation complex or the existence of an intermediate state between the molecule and the 2 atoms is postulated by the theory of absolute reaction rate; this complex determines the reaction rate. The final form which is derived for the reaction rate is

$$R = \frac{kT}{h\epsilon} e^{-\Theta/T} n_{X_2} - \frac{kT}{h\nu} n_X^2. \text{ The activated com-}$$

plex has the characteristics (ΔE (internal energy), ΔN (stoichiometric coefficient), ΔS° (standard entropy)) which minimize the entropy source of the reaction.

POT.01:003

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

THE DISSOCIATION OF A PURE DIATOMIC GAS BEHIND A STRONG NORMAL SHOCK WAVE, by G. Jarre. Nov. 1957 [17]p. incl. diagrs. tables. (Technical note no. 3) (AFOSR-TN-58-7) (AF 61(514)1124) AD 148046 Unclassified

POT.01:004 - POT.01:008

Also published in Zeitschr. Angew. Math. Phys., v. 9B: 389-403, Mar. 25, 1958.

A study of the dissociation of a pure diatomic gas behind a strong normal shock wave included: (1) an analytical discourse on the general expression of the dissociation rate; (2) the employment of simplified models of the dissociating gas and of the shock wave; (3) the analysis of heating and compression effects of the shock on the dissociation; and (4) the analysis of the space constant of relaxation. Results showed that the discontinuous transition through the shock is only controlled by the upstream Mach number, while the continuous relaxation behind the shock is only controlled by the heating effect and the compression effects. The compression effect mainly determines the space constant of relaxation or its asymptotic value. (ASTIA abstract)

POT.01:004

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

TRANSONIC FLOWS PAST SYMMETRICAL AIRFOILS WITH ATTACHED SHOCK WAVE ($M_\infty < 1$), by S. Nocilla. Dec. 1957, 26p. incl. diagrs. refs. (Technical note no. 4) (AFOSR-TN-58-63) (AF 61(514)1124) AD 148106
Unclassified

The symmetrical flow around an airfoil, with a compression shock starting from the airfoil and vanishing inside the flow is considered. The research is based on the hypothesis that the shock line vanishes at a point J inside the supersonic region of the field, instead of on the sonic line as usually occurs. After a qualitative discussion of this hypothesis, the flow is analytically determined near the point J, in both the hodograph and physical plane. (Contractor's abstract)

POT.01:005

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

AERODYNAMIC FIELD NEAR THE BLUNT LEADING EDGE OF A SYMMETRICAL AIRFOIL IN HYPERSONIC FLOW, by A. Muggia. Jan. 1958, 19p. incl. diagrs. (Technical note no. 5) (AFOSR-TN-58-213) (AF 61(514)1124) AD 154114
Unclassified

A symmetrical airfoil with a blunt leading edge in an inviscid hypersonic steady axial flow is considered, in the limit case where the undisturbed Mach number is ∞ . A method is indicated for calculating, for a given shock wave, its distance from the leading edge, the form of the profile, and the velocity and pressure distribution on it around the leading edge. The results of some numerical calculations are also given. (Contractor's abstract)

POT.01:006

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

ON NON-STEADY TRANSONIC FLOWS PAST SYMMETRICAL AIRFOILS. PART II. APPROXIMATE SOLUTION, by C. Ferrari. Jan. 1958, 10p. incl. diagrs. tables. (Technical note no. 7) (AFOSR-TN-58-320) (AF 61(514)1124) AD 154223; PB 142228
Unclassified

The complexity offered by the study of non-stationary transonic flow, even if carried out according to the hodographic method (as it will be apparent from Part I of this study) causes it to appear not altogether useless to seek a solution based on the application of rough simplifications. For this reason, the problem considered in Part I is again examined, and for its study a method is used similar to that followed by Spreiter and Alkane for the corresponding problem in stationary conditions.

POT.01:007

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

ON NON-STEADY TRANSONIC FLOWS PAST SYMMETRICAL AIRFOILS. PART I. APPLICATION OF THE HODOGRAPHIC METHOD, by C. Ferrari. Jan. 1958, 31p. incl. diagrs. (Technical note no. 6) (AFOSR-TN-58-321) (AF 61(514)1124) AD 154224; PB 142227
Unclassified

The purpose of this work is the determination of the two-dimensional flow past an airfoil placed in a stream of inviscid fluid, uniform to the infinity, under the following conditions: (a) the stream at infinity, referred to a system of axes (x^* , y^*), has a speed U_∞ and a Mach number $M_\infty < 1$ which is sufficiently high so that a supersonic region exists; (b) the symmetrical airfoil starting from a given instant, which will be conventionally considered as initial, has a translatory motion [referred to the same system (x^* , y^*)] in the direction of its symmetry axis. By applying the transformation of Legendre, the study of the problem is transferred from the physical space to the hodographic space. The equation which the transformed potential must satisfy is not linear, but is analogous to the equation of Guderley which gives this potential in the three-dimensional steady flow problem.

POT.01:008

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

OGIVE HAVING MINIMUM DRAG IN TWO-DIMENSIONAL HYPERSONIC FLOW, by E. Mattioli. June 1958 [35]p. incl. diagrs. refs. (Technical note no. 8) (AFOSR-TN-58-640) (AF 61(514)1124) AD 162171; PB 136183
Unclassified

POT.01:009, 010; PIB.11:001;
PIB.02:003

The ogive having minimum drag in hypersonic flow is determined for a given thickness, or for a given arc length, or for a given enclosed area. Fluid is assumed inviscid, the airfoil is assumed to be symmetric with zero incidence. Approximation of small disturbances is accepted, but not the linearized theory, assuming that the hypersonic similarity parameter could reach the value 2. Within these limits the flow behind the shock wave is a quasi-simple-wave, that is it may be approximate to a flow in which pressure is constant along the characteristics of one family; this is rigorously demonstrated in the proximity of the shock-wave and on the leading edge. As in these regions, the entropy gradient and rotationality are the greatest, it is assumed that the approximation has a general character over the whole field. (Contractor's abstract)

POT.01:009

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

TRANSONIC FLOWS PAST SYMMETRICAL AIRFOILS WITH ATTACHED SHOCK WAVE ($M_\infty < 1$). Part II, by S. Nocilla. July 1958, 23p. incl. diagrs. (Technical note no. 9) (AFOSR-TN-58-943) (AF 61(514)1124) AD 205083; PB 138056 Unclassified

Also published in Atti Accad. Sci. Torino. Cl. Fis. Mat. Nat., v. 93: 124-148, 1958/59.

A determination is made of the transonic flow past symmetrical airfoils at high subsonic free Mach number, with attached shock wave. The developed theory is applied to the study of Tomotika - Tamada's profiles for which the velocity-distribution on the profile, the sonic line, and the shock line are numerically determined. (Contractor's abstract)

POT.01:010

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

THE DISSOCIATION OF A PURE DIATOMIC GAS IN A LAMINAR BOUNDARY LAYER ON AN ADIABATIC FLAT PLATE, by G. Jarre. Sept. 1958 [18]p. incl. diagrs. tables. (Technical note no. 10) (AFOSR-TN-58-944) (AF 61(514)1124) AD 205082; PB 138057 Unclassified

The problem is discussed of the dissociation, produced by the friction heating, in a pure diatomic gas in a laminar boundary layer on an adiabatic flat plate at hypersonic Mach numbers. Two different and simplified methods are applied and give almost the same numerical laws describing the temperature-decay at the wall at the approaching of the chemical equilibrium state. Two numerical examples show that the considered case of dissociation is a very slow process.

PIB.11:001

Polytechnic Inst. of Brooklyn, N. Y.

PHOTOCONDUCTION IN SINGLE CRYSTALS OF ZnS, by J. J. Dropkin and F. G. Ullman. Final rept. Dec. 1, 1953-Aug. 31, 1958 [111]p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-126) (AF 18(600)692) AD 203331; PB 140850 Unclassified

Growth of ZnS crystals: Synthetic single crystals were grown by deposition of ZnS vapor obtained by sublimation of unactivated ZnS powder in an atmosphere of flowing He in a 2-zone furnace to produce crystals suitable for photoconduction measurement. The electrical behavior of single crystals of ZnS: The ac and dc photoconduction in nonluminescent natural and synthetic single crystals was investigated. Natural crystals exhibit persistent internal space charge polarization and show a Debye type of frequency dispersion in ac resistance and capacitance in the 3- to 50-c range. In synthetic crystals, dc polarization and ac dispersion effects are small, and the speed of response is slow. The differences in electrical behavior of these 2 crystal types result from the presence of deep traps in the natural crystals and their absence in the synthetic crystals. IR stimulation and quenching of photoconduction in single crystals of ZnS:Cu: The spectral response of photoconduction in the synthetic crystals was investigated from 0.5 to 2.0 μ . Two IR photocurrent peaks at 0.65 and 1.35 μ were found even in crystals not previously irradiated by UV. Photocurrents are also excited by 2537A and 3650A and each can be quenched by IR. In all crystals, and for all intensities, the sum of the UV and IR photocurrents, measured separately, is always greater than the photocurrent excited by simultaneous UV and IR. Excitation of IR photocurrent, IR absorption and quenching of UV photocurrent, IR absorption and quenching of fluorescence and excitation of IR emission have nearly identical spectral response; therefore, all probably arise from the same excitation mechanism.

PIB.02:003

Polytechnic Inst. of Brooklyn, N. Y.

STUDY OF PHASE TRANSITIONS IN WO₃ WITH A HIGH-TEMPERATURE X-RAY DIFFRACTOMETER, by J. A. Perri, E. Banks, and B. Post. July 12, 1957 [4]p. incl. diagrs. [Technical note no. 3] (AFOSR-TN-58-285) (AF 18(600)1193) AD 154189 Unclassified

Also published in Jour. Appl. Phys., v. 28: 1272-1275, Nov. 1957.

WO₃ undergoes a phase transformation from monoclinic to orthorhombic at approximately 320°C and from orthorhombic to tetragonal at 720°C. A detailed study of the variation of the unit cell dimensions over the range from room temperature to 1000°C has been carried out using high-temperature x-ray diffraction techniques.

PIB.02:004; PIB.04:007-009

Some unique features of the apparatus are described in this paper. Between the 320°C and 720°C transformations, the a and c axes increase uniformly in length while the b axis decreases. There is a marked increase in the volume of the unit cell below the orthorhombic to tetragonal transformation; the volume decreases sharply in the transformation and resumes its "normal" increase above 720°C. (Contractor's abstract)

PIB.02:004

Polytechnic Inst. of Brooklyn, N. Y.

RARE EARTH METAL "DISILICIDES", by J. A. Perri, I. Binder, and B. Post. [1958] [10]p. incl. diagrs. tables. [Technical note no. 4] (AFOSR-TN-58-1054) (AF 18(600)1193) AD 206982 Unclassified

Also published in Jour. Phys. Chem., v. 63. 616-619, Apr. 1959.

Disilicides of Ce, Pr, Nd, Sm, Eu, Gd, Dy and Y have been prepared. The Ce, Pr and Nd compounds are tetragonal as previously reported; the Sm, Gd, Dy and Y compounds are orthorhombic, space group Imma. Their structures are slightly distorted versions of the tetragonal MeSi_2 structures. The magnitude of the distortion appears to increase with decreasing size of the metal atom. Chemical and x-ray diffraction studies of " GdSi_2 " indicate that the composition is close to

$\text{GdSi}_{1.4}$. EuSi_2 crystallizes in the tetragonal system apparently due to the anomalously large size of the metal atom. (Contractor's abstract)

PIB.04:007

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A PHENOMENOLOGICAL THEORY OF THE FREE TURBULENT FLOW OF A NON-REACTING BINARY GAS MIXTURE, by L. G. Napolitano. Dec. 1956, 46p. incl. refs. (PIBAL rept. no. 317) (AFOSR-TN-57-39) (AF 18(600)693) AD 115077 Unclassified

Classical results of the kinetic theory of non-uniform gases are used to derive the basic equations describing the free turbulent motion of a non-reacting binary gas mixture. Upon extension of the Reynolds similarity concept, all conductive currents are neglected and the resulting equations are presented in curvilinear orthogonal coordinates. Turbulent transport fluxes are defined and their analogy with the corresponding molecular conductive currents discussed. These turbulent fluxes are subsequently related to pertinent mean gradients through phenomenologically defined eddy coefficients. Turbulent Prandtl (Pr^t), Schmidt (Sc^t) and Lewis (Le^t) numbers are introduced by means of non-dimensional grouping of these coefficients. The boundary layer approximation

to the basic equations is successively derived and the simplifications connected with the assumptions $\text{Sc}^t = \text{Pr}^t = 1$ investigated. First integrals of the diffusion and energy equations are found, which simply express linear dependence of mass concentration and total stagnation enthalpy of the mixture on the velocity ratio. (Contractor's abstract)

PIB.04:008

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

TURBULENT MIXING OF TWO NON-REACTING GASES, by L. G. Napolitano. Jan. 1957, 49p. incl. table. (PIBAL rept. no. 323) (AFOSR-TN-57-41) (AF 18(600)-693) AD 115079 Unclassified

A preliminary investigation of two-dimensional free turbulent mixing of two non-reacting gases in the absence of axial pressure gradients is presented. A linear dependence on the velocity ratio of mass concentration and stagnation enthalpy of the mixture is proved to exist when the turbulent Prandtl and Schmidt numbers are both assumed to be one. The possibility of determining the combined effects of velocity, temperature, and concentration gradients by means of solutions of a single total differential equation is demonstrated. Two forms of the fundamental equation are derived under the hypothesis of constancy, along cross sections of the flow, of either the turbulent exchange coefficients or the mixing lengths. Several particular cases are examined and instances wherein the subject problem is reduced to well known solutions of turbulent mixing with uniformity in concentration are given. (Contractor's abstract)

PIB.04:009

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

GENERALIZATION OF INTEGRAL RELATIONSHIPS WITH APPLICATIONS IN WING-BODY INTERFERENCE, WING THEORY, AND DIFFRACTION OF PULSES, by L. Ting. Apr. 1957 [44]p. incl. diagrs. refs. (PIBAL rept. no. 379) (AFOSR-TN-57-159) (AF 18(600)693) AD 126451 Unclassified

A theorem is proved concerning the integrated properties of the linearized pressure distribution on a cylindrical surface in a supersonic stream when the normal velocity on the cylindrical surface is prescribed. The theorem is a generalization of the integral relationships concerning certain properties of (1) the linearized pressure fields due to a planar source distribution in a supersonic stream; (2) extensions of these properties to a class of 3-dimensional problems which involve biplanes or cruciform wing arrangements; (3) the pressure integral along the line of intersection of a forward Mach

cone with a specified nonplanar surface which is a prismatic body of rectangular cross section mounted on a planar wing with supersonic edges; (4) the normal velocity prescribed on the side walls of the body; and (5) the cylindrical surface of the form of a stairway with a finite number of steps. The theorem is useful in the evaluation of total lift and drag of wing-body combinations when the linear dimensions of the cross section of the body are not small as compared to the chord length. The theorem is applied in the derivation for lift and drag of a rectangular wing with a constant zero thickness profile in supersonic flight without the use of Ervard's (NACA TN 1382) result. For the diffraction of a pulse or a weak shock over a rectangular notch, a pressure integral theorem is obtained. Its usefulness is demonstrated in reducing the labor of obtaining the mean pressure distribution along any depth inside the notch at different instants for various width-height ratios of the notch.

PIB.04:010

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

SOME REMARKS ON THE SOLUTION OF A SYSTEM OF EQUATIONS OCCURRING IN LAMINAR MIXING WITH AXIAL PRESSURE GRADIENTS, by L. G. Napolitano. Sept. 1957 [15]p. incl. diagrs. (PIBAL rept. no. 393) (AFOSR-TN-57-609) (AF 18(600)693) AD 136599 Unclassified

A fifth order system of equations with three-point boundary considerations is investigated from the point of view of obtaining solutions by means of high speed computing machine. The subject system occurs in the study of laminar mixing in the presence of axial pressure gradients. Two methods of solution are outlined: In the first one a suitable change of variables reduces the original equations to integro-differential equations defined over a finite interval of the independent variable. An iteration scheme is subsequently adopted and asymptotic solutions, as needed to compute the solution in the proximity of the end points, are presented. The second method considers the solution as an "initial value" problem. The four-fold indeterminacy which arises when the solution is started from the point $\sigma = 0$ is shown to be reducible to a two-fold one. The two parameters left are related to the attainment of the required asymptotic behavior of the solution. (Contractor's abstract)

PIB.04:011

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

INCOMPRESSIBLE MIXING OF A SHEAR FLOW WITH FLUID AT REST, by L. G. Napolitano. Nov. 1957 [44]p. incl. diagrs. refs. (PIBAL rept. no. 318) (AFOSR-TN-57-754) (AF 18(600)693) AD 136743 Unclassified

The laminar and turbulent mixing of a non-uniform free stream with fluid at rest is investigated. Laminar and turbulent vorticity numbers are defined, which indicate the relative importance of the free stream vorticity as compared to the average vorticity present in the wake. Solutions of the subject problem are given to a first approximation in the vorticity numbers. The quantitative analysis shows that the presence of vorticity in the outer stream can be used as a practical and efficient device to control the transfer of properties between two different streams. (Contractor's abstract)

PIB.04:012

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

HIGH SPEED MACHINE SOLUTIONS FOR PLANE TURBULENT HOMOGENEOUS AND NON-HOMOGENEOUS MIXING, by L. G. Napolitano. Oct. 1957, 37p. incl. tables. (PIBAL rept. no. 399) (AFOSR-TN-57-755) (AF 18(600)693) AD 136744 Unclassified

Numerical values as obtained from high speed machine solutions of the total differential equation governing two-dimensional, plane, turbulent homogeneous and non-homogeneous mixing are presented for a parabolic variation of the density ratio with the velocity ratio. Each solution is identified by the values of three parameters characterizing flow properties and nature of the free streams. A total of 28 cases is given, covering a wide range of these parameters. The pertinent formulae relating the tabulated values to the essential physical quantities of the flow field are also presented. (Contractor's abstract)

PIB.04:013

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

TWO-DIMENSIONAL PLANE MIXING OF HOMOGENEOUS AND NON-HOMOGENEOUS STREAMS, by L. G. Napolitano. Nov. 1957 [48]p. incl. diagrs. tables, refs. (PIBAL rept. no. 400) (AFOSR-TN-57-756) (AF 18(600)-693) AD 136745 Unclassified

High speed machine solutions of isobaric turbulent mixing of two semi-infinite streams are analyzed. The solutions (based on unitary turbulent Prandtl and Schmidt number and on a parabolic density-velocity relationship) apply to (1) homogeneous mixing, and (2) heterogeneous mixing of: (a) gases having the same number of degrees of freedom; (b) gases having the same molecular weight but specific heat differences that are small compared to velocity differences; (c) gases having the same specific heats but molecular weight differences that are small compared to velocity differences; and (d) streams with differences in the molar heat capacities small compared to velocity differences. For all these cases a particular

PIB.04:014-016; PIB.05:007, 008

solution depends upon the values of three parameters describing nature and properties of the free streams. Velocity profiles in terms of the similarity variable $\sigma = y/x^{1/2}$ have appeared to be substantially independent of the nature of the interacting gases, the free stream stagnation enthalpy ratio and the Mach number. Based on these results, explicit approximate solutions are presented which prove to be very satisfactory when compared with the available exact ones. (Contractor's abstract)

PIB.04:014

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

CRITICAL STUDY OF THE ADEQUACY OF INTEGRAL METHODS IN PLANE MIXING PROBLEMS, by L. G. Napolitano. Dec. 1957, 1v. incl. illus. tables. (PIBAL rept. no. 425) (AFOSR-TN-57-757) (AF 18(600)693) AD 136746. Unclassified

Solutions of plane isobaric homogeneous mixing by integral methods are presented. Incompressible and compressible, laminar and turbulent cases are shown to be reducible to the solution of a unique laminar-incompressible-type system of equations. The third boundary condition, to be imposed on the y-component of the velocity, is proved to be inessential. The solution is given in a transformed (ζ, η_1) plane wherein the streamline through the origin is taken to coincide with the ζ -axis. Solutions of plane mixing problems subject to arbitrary boundary condition on the y-component of the velocity are related to the previous one through simple transformation formulae. Sixth degree polynomials are assumed for the velocity profiles and the solution of the basic equations is made to depend upon a single algebraic quadratic equation when the flow fields are similar. The accuracy of the method is determined by comparison with some high speed machine solutions of the pertinent Blasius equation and it proves to be extremely satisfactory. Comparative study of the accuracy obtained (1) by integral methods with fourth, sixth and seventh degree polynomials, and (2) by series solution of the Blasius equation is also made. It appears that sixth degree polynomials are the most accurate velocity profiles and that their accuracy is comparable with that of the series solution for large values of the free stream velocity ratio, but it is definitely better for small values of the aforementioned ratio. (Contractor's abstract)

PIB.04:015

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A REVIEW OF THE WORK PERFORMED AT PIBAL

UNDER CONTRACT AF 18(600)693, by A. Ferri. Oct. 1957, 12p. (AFOSR-TR-57-74) (AF 18(600)693) AD 136624. Unclassified

Theoretical and experimental investigations of inviscid and viscous flow problems are reviewed. The connection between these studies and problems bearing on very high speed flight is indicated. Some potentialities of this work for extension beyond the range of available information are outlined.

PIB.04:016

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

THE AXISYMMETRIC SUPERSONIC FLOW NEAR THE NOSE OF A POINTED BODY OF REVOLUTION, by L. G. Napolitano and A. Ferri. [1957] [5]p. incl. diagrs. refs. (AF 18(600)693; continued by AF 49(638)217) Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 900-904, Dec. 1957.

An approximate method of solution for the supersonic flow about axisymmetric bodies is given. It is based on the method of linearized characteristics and is shown to provide a rapid and accurate means of calculation. The method has the advantage that its limits of applicability are easily determined. As a numerical example, the flow about the nose of the RM-10 body has been analyzed for several flight Mach numbers and the results shown to be in good agreement with other methods of analysis. (Contractor's abstract)

PIB.05:007

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A THEORETICAL AND EXPERIMENTAL ANALYSIS OF A NEW METHOD OF REDUCING AERODYNAMIC HEATING (Unclassified title), by A. Ferri, V. Zakkay, and P. A. Libby. Mar. 1957 [38]p. incl. diagrs. tables. (PIBAL rept. no. 325) (AFOSR-TN-57-113) (AF 18(600)694) AD 120466. Confidential

PIB.05:008

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

AN INVESTIGATION OF THE ADVANTAGEOUS USE OF INTERFERENCE EFFECTS IN THE DESIGN OF SUPERSONIC INLETS. PART II. EXTERNAL LIFT AND DRAG CALCULATIONS FOR AN INLET INSTALLATION AT $M = 3.15$ (Unclassified title), by A. Casaccio. Feb. 1957 [23]p. incl. diagrs. (PIBAL rept. no. 322) (AFOSR-TN-57-126) (AF 18(600)694) AD 120481. Confidential

PIB.05:009

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

FAVORABLE INTERFERENCE IN LIFTING SYSTEMS IN SUPERSONIC FLOW, by A. Ferri, J. H. Clarke, and L. Ting. Nov. 1957 [14]p. incl. diagrs. refs. (PIBAL rept. no. 430) (AFOSR-TN-58-19) (AF 18(600)694) AD 148058 Unclassified

Presented at Twenty-fifth annual meeting of the Inst. of Aeronaut. Sciences, New York, Jan. 28-31, 1957.

Also published in Jour. Aeronaut. Sciences, v. 24: 791-804, Nov. 1957.

Certain simple integral relations are applied to the qualitative assessment and calculation of the favorable interference effects arising in various spatial arrangements of wings and bodies in a supersonic stream. The arrangements include slender bodies in proximity to wings, wings with underslung pylons or other vertical surfaces, and wing-fuselage combinations. The elementary considerations used in these examples serve to demonstrate to the designer how the pressure drag due to volume and lift can be reduced by arranging the several components comprising the configuration so that they exhibit mutually advantageous shapes and orientations. Vertically antisymmetric modifications of the fuselage shape in the neighborhood of the midwing are suggested which reduce the drag due to lift of mid-wing-body systems. The considerations are different from those giving rise to the supersonic area rule, according to which vertically symmetric fuselage indentations are made in order to reduce the drag due to thickness or volume, and might have comparable significance. (Contractor's abstract)

derived in the present report. Furthermore, the integral of the pressure along the line of intersection of a Mach plane with the wing surface can be obtained from the integral of the prescribed normal velocity by the integral relationship derived in a previous report. With this information the pressure distribution on the wing can be represented by a function of 2 variables which assume the proper values along the Mach lines issuing from the vertex of the wings and along the line of intersection of the wings. The remaining arbitrary constants in the function are determined by the integral relationships corresponding to the Mach planes at various orientations. If the normal velocity on the wing surface is constant, the approximate solution with only one arbitrary constant, determined by one integral relationship, is in good agreement with the linearized conical solution. If in the approximate solution, there are 2 arbitrary constants, determined by 2 integral relationships, the result is in perfect agreement with linearized conical solution. When the normal velocity on the wing surface can be represented by a power series of 2 variables, the general procedure of obtaining an approximate solution is outlined and illustrated by an example. Finally, a partially swept-back wing with dihedral is chosen as a working example, and the detail pressure distribution on the wing is obtained.

PIB.05:011

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

(CLASSIFIED TITLE), by V. Zakay and R. J. Cresci. Mar. 1958, 1v. incl. illus. (PIBAL rept. no. 437) (AFOSR-TN-58-255) (AF 18(600)694) AD 154159 Confidential

PIB.05:012

Polytechnic Inst. of Brooklyn, Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

SOME ASPECTS OF DRAG REDUCTION FOR LIFTING WING-BODY COMBINATIONS AT SUPERSONIC SPEED, by L. Ting. May 1958, [27]p. incl. diagrs. tables. (PIBAL rept. no. 445) (AFOSR-TN-58-423) (AF 18(600)694) AD 158226 Unclassified

An investigation was undertaken which shows that for a prismatic body of rectangular cross section with given volume (or cross section area) mounted on a mid-wing of given span and swept back, the lift-drag ratio of the wing-body combination with the favorable antisymmetric modifications will be higher if the basic body has a lower height-width ratio. For bodies with height-width ratio equal to 1 to 2, the favorably contoured wing-body combination has almost the same value of lift-drag ratio as that of a favorable planar lifting surface which possesses zero volume and is composed of the wing and the projection of the body on the plane of the wing. With further

PIB.05:010

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

PRESSURE DISTRIBUTION ON DIHEDRAL WINGS AT SUPERSONIC SPEED, by L. Ting. Jan. 1958, 46p. incl. diagrs. (PIBAL rept. no. 397) (AFOSR-TN-58-86) (AF 18(600)694) AD 148135 Unclassified

Also published in Jour. Fluid Mech., v. 6: 302-312, Aug. 1959.

For the problem of supersonic flow over wings with supersonic edges, with dihedral and with arbitrary twist, camber, and thickness distributions, the pressure distributions on and outside the Mach cone issuing from the vertex of the wing are equal to the corresponding solutions for planar wings. The pressure distribution along the line of intersection of the wings is obtained from the corresponding solution for planar wings by virtue of the averaging properties of solutions of wave equations

PIB.05:013-016; PIB.06:006

increase in the height-width ratio the lift-drag ratio of the favorably contoured wing-body configurations, with the same projected planform, decreases slightly while the volume increases linearly with the height-width ratio. The effect of contouring the vertical surface which does not support lift of the subject wing-body configurations, results in an increase of 5 to 10% in the lift-drag ratio depending on the height-width ratio and also the ratio of the area of the lifting (horizontal) surface to that of the non-lifting (vertical) surface. Calculations for a simple model of wing-body combination are made to study the effect of favorable interference at off-design conditions. For a given value of lift coefficient, the drag varies in the same manner as a planar wing when the Mach number deviates from the designed value.

PIB.05:013

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

EXPERIMENTAL INVESTIGATION OF SOME HEAT-TRANSFER PROBLEMS UNDER HYPERSONIC CONDITIONS (Unclassified title), by P. A. Libby. May 1958 [43]p. incl. illus. diagrs. refs. (PIBAL rept. no. 442) (AFOSR-TN-58-424) (AF 18(600)694) AD 158227

Confidential

Presented at classified meeting of the Institute of the Aeronautical Sciences Guided Missiles, St. Louis, Mo., May 12-14, 1958.

PIB.05:014

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

STUDY OF DRAG REDUCTION OF HIGH-WING CONFIGURATIONS AT SUPERSONIC SPEEDS, by R. Parthasarathy. Oct. 1958 [21]p. incl. diagrs. (PIBAL rept. no. 456) (AFOSR-TN-58-837) (AF 18(600)694) AD 203001; PB 145566

Unclassified

The possibility of drag reduction of wing-body combinations at all practical values of the lift coefficient, by a proper distribution of the body volume, is explored. This is illustrated by modifying a midwing configuration, composed of a full circular cone, symmetrically disposed about the sweptwing of zero thickness, to a high-wing configuration, composed of the same wing, but two half cones of equal volume as the full cone, mounted beneath the wing. It is found that at $M = 3.0$ and lift coefficient = 0.1, for a cone of semi-vertex angle $\theta_c = 5^\circ$,

the high-wing configuration gives a drag reduction of 16% over that of the corresponding midwing configuration whereas there is found to be a drag reduction of 6.5% at $M = \sqrt{2}$. Similar comparison for the percentage increase in lift drag ratio for the above-mentioned configurations shows a maximum increase of 34% at

$M = 3.0$ for the high-wing configuration over the midwing configuration, whereas it is 22% at $M = \sqrt{2}$. Numerical results show that the high-wing configuration gives a significant reduction in drag as compared to a midwing configuration of equal volume and furthermore, greater reductions in drag are obtained at higher Mach numbers. (Contractor's abstract)

PIB.05:015

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

AN EXPERIMENTAL INVESTIGATION AT $M = 3.09$ OF THE PRESSURE DISTRIBUTION OVER A TANGENT-OGIVE WITH UPSTREAM SPIKES (Unclassified title), by A. Martellucci and M. Visich, Jr. June 1953 [34]p. incl. illus. diagrs. tables, refs. (PIBAL rept. no. 446) (AFOSR-TN-58-838) (AF 18(600)694) AD 302096

Confidential

PIB.05:016

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

SOLUTIONS OF SUPERSONIC INTERFERENCE PROBLEMS BY GENERALIZED INTEGRAL RELATIONSHIP. EXAMPLES FOR A CIRCULAR CYLINDRICAL BODY, by L. Ting. Oct. 1958 [43]p. incl. diagrs. (PIBAL rept. no. 465) (AFOSR-TN-58-1069) (AF 18(600)694) AD 207229; PB 145482

Unclassified

The generalized integral relationship is employed to solve the interference problem of wings and cylindrical bodies of arbitrary cross section. The procedure is to represent the pressure distribution of the body and the wing inside the interference region by a linear combination of a finite number of elementary functions of the surface variables. The combination fulfills the condition that the pressure is continuous inside the interference region and also across its boundary. The arbitrary constants in the combination are determined by the generalized integral relationship which will be reduced to a set of simultaneous linear algebraic equations. A numerical example is carried out for a circular cylindrical body mounted on a semi-infinite plate. The results are in agreement with those obtained by Nielsen by a different theoretical method. The inverse matrix of the simultaneous equation in the present numerical analysis is tabulated so that the labor of solving the problem with a different prescribed normal velocity is substantially reduced. (Contractor's abstract)

PIB.06:006

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

ELASTIC ANALOG FOR PRIMARY CREEP, by N. J. Hoff. n.d., 7p. (AF 18(600)1381)

Unclassified

PIB.06:007 - PIB.06:011

Elastic analogues are developed for the primary creep problem. The strain rate is assumed to be a function of the instantaneous values of the stress and the strain to the extent that an approximate mechanical equation of state can be assumed for the system. A power law is assumed for the stress-strain relationship, and an expression for the strain rate is obtained. A model is assumed in which surface tractions $T_1(x, t)$ and body forces $\phi(x, t)$ are applied to one section S_1 of the body, and the remaining section of the body S_2 is slowly displaced with given velocities $V_1(x, t)$. Boundary conditions are given relating the applied traction and body forces, strain rate tensor, and displacement velocities. Elastic analogues are established for two cases: (1) $V_1 = 0$ on S_2 and (2) $\phi_1 = 0$, $T_1 = 0$ on S_1 .

PIB.06:007

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

CREEP BEHAVIOR OF CIRCULAR PLATES, by B. Venkatraman and P. G. Hodge, Jr. Mar. 1957, 27p. incl. diagrs. table, refs. (PIBAL rept. no. 369) (AFOSR-TN-57-135) (AF 18(600)1381) AD 120491
Unclassified

Also published in Jour. Mech. and Phys. of Solids, v. 6: 163-176, 1958.

The creep behavior of circular plates is analysed on the assumption that steady state creep conditions prevail. The creep law is based upon a flow rule associated with a condition of maximum shearing stress. The method is applied to plates with simply supported and clamped edges. Closed forms solutions for moments and creep deformations are presented.

PIB.06:008

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

SOLUTIONS OF SOME PROBLEMS IN STEADY CREEP, by B. Venkatraman. July 1957 [120]p. incl. diagrs. tables, refs. (PIBAL rept. no. 402) (AFOSR-TN-57-388) (AF 18(600)1381) AD 132463
Unclassified

The present work is concerned with the analysis of structures in which the deformations are caused exclusively by steady creep. The particular problems considered are trusses, beams and frames, a thick-walled tube subject to uniform internal pressure, pure torsion of prismatic and cylindrical bars, and circular plates under normal pressure. Some of the problems are analysed with the elastic analogue as basis, while others are based on a creep flow law formulated in quite simi-

lar terms to those of plastic flow. In all cases, exact and/or approximate solutions are presented for stresses and deformations. (Contractor's abstract)

PIB.06:009

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

CREEP DEFORMATIONS OF RECTANGULAR FRAMES, by F. W. French, Jr., S. A. Patel, and N. J. Hoff. July 1957 [29]p. incl. illus. diagrs. table. (PIBAL rept. no. 340) (AFOSR-TN-57-714) (AF 18(600)1381) AD 136707
Unclassified

A theoretical and experimental investigation was made of the behavior of rectangular frames of 5052-O Al alloy subjected to loads at 500°F. The displacement velocities of the point of application of the load were measured and compared to the results of theoretical analyses. The agreement can be considered satisfactory considering that primary creep was disregarded. (ASTIA abstract)

PIB.06:010

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

EFFECT OF HIGHER-HARMONIC DEFLECTION COMPONENTS ON THE CREEP BUCKLING OF COLUMNS, by S. A. Patel and J. Kempner. [1957] 11p. incl. diagrs. [AF 18(600)1381]
Unclassified

Published in Aero. Quart., v. 8: 215-225, Aug. 1957.

This analysis shows that the higher-harmonic deflection components reduce the column lifetime significantly only when their initial amplitudes, as well as the initial amplitude of the first harmonic component, are very large. Furthermore, it is shown that second-harmonic components have a much smaller effect on the column behavior than do third-harmonic components. (Contractor's abstract)

PIB.06:011

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

EXPERIMENTAL INVESTIGATION OF CLAMPED CIRCULAR PLATES SUBJECTED TO RAPID CREEP, by B. Erickson, S. A. Patel, and N. J. Hoff. July 1957 [10]p. incl. diagrs. (PIBAL rept. no. 411) (AFOSR-TN-58-51) (AF 18(600)1381) AD 148093
Unclassified

Twenty-one clamped circular plates were tested at an elevated temperature under uniform lateral pressure. The plates were 12 in. in diameter and were made of 5052-O aluminum alloy sheet. Sheet thicknesses of

PIB.06:012; PIB.12:001-0C3

0.032, 0.040, 0.051 and 0.064 in. were used. The plates were maintained at 500°F in an oven and were subjected to a constant uniform lateral pressure. The lateral deflection of the center of the plate was measured in each test. Curves showing the change in deflection with time are presented. (Contractor's abstract)

PIB.06:012

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

INVESTIGATIONS CONDUCTED AT THE POLYTECHNIC INSTITUTE OF BROOKLYN ON STRESSES IN STRUCTURAL ELEMENTS IN THE PRESENCE OF CREEP. Final summary technical rept. Feb. 1, 1955-June 30, 1957. Jan. 1958, 7p. (PIBAL rept. no. 418) (AFOSR-TR-58-12) (AF 18(600)1381) AD 148092

Unclassified

Part I-Theoretical phase: Indications were that elastic and plastic analogs exist for both transient and steady creep conditions. Creep problems in column, beam, tube, truss, frame, and plate structures were solved. Experimental phase: Two types of creep experiments were performed. One involved rectangular frames subject to the 2 opposing loads in the plane of the frame. The experimental deflection rates obtained were in good agreement with theoretical predictions. The second type of test involved damped circular plates subject to uniform lateral pressure and to rapid creep. Part II: Abstracts of all technical reports published under the subject contract are presented with concise remarks relative to the significance of the results, and a comparison with the results of other applicable investigations.

PIB.12:001

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

HETEROGENEOUS TURBULENT MIXING, by L. G. Napolitano. [1958] [30]p. incl. diagrs. table, refs. (AFOSR-TN-58-5) [AF 49(638)217; continuation of AF 18(600)693] AD 148044

Unclassified

This paper deals with the solution of some particular cases of non-homogeneous isobaric turbulent plane mixing. Momentum, energy, diffusion, continuity and state equations, are presented for the general case of non-isobaric free turbulent motion of a non-reacting binary gas mixture in curvilinear orthogonal coordinates. Two-dimensional plane isobaric motion is considered in detail within the boundary-layer approximation. Assuming similarity and other given conditions, the basic equations are reduced to a single total differential equation for the non-dimensional stream function. In the resulting equation the density ratio appears as a rational function of the velocity ratio. Simple approximate so-

lutions of the subject flow fields are derived and density profiles are computed from approximate velocity profiles obtained by the integral method.

PIB.12:002

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

INCOMPRESSIBLE MIXING OF A SHEAR FLOW WITH FLUID AT REST, by L. G. Napolitano. [Feb. 1958] [34]p. incl. diagrs. refs. (AFOSR-TN-58-127) [AF 49(638)217] AD 152154

Unclassified

Also published in Jour. Aero/Space Sciences, v. 25: 444-450, July 1958.

The laminar and turbulent mixing of a nonuniform free stream with fluid at rest is investigated. Laminar and turbulent vorticity numbers are defined, which measure the relative importance of the free-stream vorticity as compared to the average vorticity present in the wake and which increase with the square root of x and with x , respectively. Solutions of the subject problem are given to a first approximation in the vorticity numbers. In comparing the characteristics of the mixing due to a non-uniform stream $u_1 = \omega y$ with those due to the uniform stream $u = u_0$, it is found that vorticity effects over a given length are nearly always negligible in the laminar case but became sizable in the turbulent case. This is due to the usually higher rate of increase with x of the turbulent vorticity number. Results of the analysis, as applied to streams having constant vorticity over finite y -length, indicate the practicability of the use of outer vorticity as a means to control the rate of transfer of properties between two different streams. (Contractor's abstract)

PIB.12:003

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

ISOBARIC HOMOGENEOUS MIXING BY INTEGRAL METHODS, by L. G. Napolitano. [1958] 40p. incl. diagrs. tables, refs. (AFOSR-TN-58-128) (AF 49(638)217) AD 152155

Unclassified

Solutions of plane isobaric homogeneous mixing by integral methods are presented. It is first shown that, under some usually accepted restrictive hypotheses, incompressible and compressible, laminar and turbulent cases are reducible to the solution of a unique laminar-incompressible-type system of equations. The solution is then given in a transformed (ξ, η) -plane wherein the streamline through the origin is taken to coincide with the ξ -axis. Solutions of plane mixing problems subject to arbitrary boundary conditions on the y -component of the velocity are related to the previous one through

PIB.12:004 - PIB.12:007

simple transformation formulas. Sixth degree polynomials are assumed for the velocity profiles and the solution of the basic equations is made to depend upon a single algebraic quadratic equation. The accuracy of the method is determined by comparison with some high speed machine solutions of the pertinent Blasius equation and it proves to be extremely satisfactory. Comparative study of the accuracy obtained: (1) by integral methods with fourth, sixth and seventh degree polynomials, and (2) by series solution of the Blasius equation is also made. It appears that the integral method with sixth degree polynomials yields the best overall accuracy and that the superiority of the present method increases as the free stream velocity ratio decreases.

PIB.12:004

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A THEORETICAL AND EXPERIMENTAL INVESTIGATION AT A MACH NUMBER OF 3.09 OF A LOW-DRAG AUXILIARY BODY UTILIZING FAVORABLE INTERFERENCE, by A. Martellucci. Dec. 1957 [43]p. incl. illus. diags. tables, refs. (PIBAL rept. no. 432) (AFOSR-TN-58-175) (AF 49(638)217) AD 152208
Unclassified

An experimental investigation at a Mach number of 3.09 of a low-drag auxiliary body, zero lift system, has been conducted. The design of the body was carried out by nonlinear methods of flow analysis. The test Reynolds number per foot for the entire program was 3.37×10^7 . The body can be applied to the problem of external storage under a wing or as an auxiliary ramjet engine to be used, for example, during acceleration. A drag coefficient of 0.0094 based on a reference area (maximum cross sectional area) of 2.120 sq in. was determined experimentally for the body in the proximity of the wing. The capture area of the body is 3.53 sq in. and the Mach number at the minimum section is 1.6. The method of design, a description of the test setup, discussion of the test results and the possible applications of the system are presented. (Contractor's abstract)

PIB.12:005

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

ON THE MIXING OF TWO PARALLEL STREAMS, by L. Ting. July 1958 [26]p. incl. diags. table, refs. (PIBAL rept. no. 441) (AFOSR-TN-58-628) (AF 49-638)217) AD 162158
Unclassified

Also published in Jour. Math. and Phys., v. 38: 153-165, Oct. 1959.

With the employment of the techniques of boundary

layer theory, the proper third boundary condition for the mixing of two parallel streams is derived from the compatibility condition of the higher order approximation. It is shown that the commonly adopted third boundary condition of balancing of transverse momentum is correct only for the mixing problem of two semi-infinite incompressible streams. For the fulfillment of the proper third boundary condition, the possibility of introducing the similar solution of Blasius type is examined for various cases. (Contractor's abstract)

PIB.12:006

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

ON THE SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS, by M. Epstein. [1958] [2]p. incl. diags. table. (AFOSR-TN-58-715) (AF 49(638)217) AD 162250
Unclassified

Also published in Jour. Aero/Space Sciences, v. 26: 58-59, Jan. 1959.

The author transforms Prandtl's boundary-layer equation into a non-linear integral equation for the shearing function and solves this equation by iteration. He chooses the first approximation in such a way that it satisfies the boundary conditions and has the correct asymptotic behavior at infinity. Application to the shearing stress distribution on a circular cylinder and other examples shows good agreement with the exact solutions.

PIB.12:007

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

THEORETICAL PRESSURE DISTRIBUTION ON A HEMI-SPHERE-CYLINDER COMBINATION, by A. Casaccio. [1958] [2]p. incl. diags. (AFOSR-TN-58-717) (AF 49-638)217) AD 162252
Unclassified

Also published in Jour. Aero/Space Sciences, v. 26: 63-64, Jan. 1959.

In recent years great use has been made of approximate methods for the determination of the pressure distribution on blunt-nosed bodies and afterbodies at high Mach numbers. For quasi-spherical bodies it has been suggested that modified Newtonian theory in combination with a Prandtl-Meyer expansion be used on the nose portion, the two laws being matched at the point where the pressure gradients are equal. No simple approximation, however, has been found for flat-nosed bodies. As for the pressure distribution on the afterbody, the blast-wave analogy has been suggested for general nose shapes but particular afterbody profiles. The purpose of this note

PIB.12:008 - PIB.12:011

is to compare these approximate estimates with a more accurate determination of the flow field about a hemisphere-cylinder in an ideal gas flow at $M = 20$.

PIB.12:008

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

THEORETICAL AND EXPERIMENTAL ANALYSIS OF A COWLING AS A MEANS OF DRAG REDUCTION FOR AN AXISYMMETRIC CENTER BODY, by M. Visich, Jr. and A. Martellucci. Aug. 1958 [35]p. incl. illus. diagrs. tables, refs. (PIBAL rept. no. 451) (AFOSR-TN-58-760) (AF 49(638)217) AD 162273 Unclassified

Also published in *ARS Jour.*, v. 29: 447-449, June 1959.

A theoretical and experimental investigation at $M = 3.09$ of an axisymmetric boat-tailed center body surrounded by a cowl ring was conducted. The design of the body was accomplished by the method of characteristics for axisymmetric irrotational flow for zero angle of attack. The test Reynolds number per foot for the entire program was 3.37×10^7 and the flight attitude for the tests was at zero angle of attack. The configuration studied can be used as an independent flight vehicle with a circular wing. It can also be used as an auxiliary ramjet engine or external storage system for long range vehicles. For the optimum configuration considered, a total drag reduction of 61.8% was measured over the center body alone. Comparison of the total drag of the optimum configuration to that of a cone with the same volume and length as the center body indicates a reduction of 47%. The method of design, a description of the experimental equipment, discussion of the test results, and the possible applications of the system are presented in this report. (Contractor's abstract)

PIB.12:009

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

THE THREE-DIMENSIONAL COMPRESSIBLE LAMINAR BOUNDARY LAYER, by M. Epstein. Oct. 1958 [77]p. incl. diagrs. table, refs. (PIBAL rept. no. 455) (AFOSR-TN-58-894) (AF 49(638)217) AD 204135; PB 143510 Unclassified

A method is presented for determining approximate solutions to the 3-dimensional compressible laminar boundary layer equations. The proposed method resembles the classical integral method, and is designed to overcome one of the principal difficulties in that method, namely the problem of choosing appropriate analytical representations of the boundary layer profiles. An iteration procedure was developed wherein improved approximations to the boundary layer profiles are generated from a set of simple initial profiles.

The present method requires the satisfaction of 2 integral conditions by each of the improved profiles. The first iteration, for any given initial choice of profiles, should give an improvement over the standard integral method. A comparison of results predicted by the present method with known exact solutions of 2- and 3-dimensional problems indicates that one iteration is sufficient to obtain engineering accuracy for a wide range of problems. The application of the method to a more general 3-dimensional problem is illustrated by calculating the development of the boundary layer along the stagnation line of a wing with a curved leading edge. (ASTIA abstract)

PIB.12:010

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

PRESSURE DISTRIBUTIONS ON A TWO-DIMENSIONAL BLUNT-NOSED BODY AT VARIOUS ANGLES OF ATTACK, by V. Zakkay and A. K. Fields. Oct. 1958, 22p. incl. illus. diagrs. (PIBAL rept. no. 461) (AFOSR-TN-58-1016) (AF 49(638)217) AD 162281; PB 145481 Unclassified

Pressure measurements have been made for a two-dimensional blunt-nosed body in order to determine the effect of angle of attack on the pressure distribution. It is shown that the Newtonian theory does not apply to bodies where the sonic point does not fall on the same radius of curvature as the stagnation point. A large reduction in stagnation point heat transfer was obtained as a result of increasing the radius of curvature of the body at the sonic point over that which exists at the stagnation point of constant radius of curvature models. (Contractor's abstract)

PIB.12:011

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

RECENT WORK ON MIXING AT THE POLYTECHNIC INSTITUTE OF BROOKLYN, by L. G. Napolitano, P. A. Libby, and A. Ferri. [1958] [35]p. incl. illus. diagrs. table, refs. [AF 49(638)217] Unclassified

Published in *Combustion and Propulsion, Third Agard Colloquium: Noise, Shock Tubes, Magnetic Effects, Instability and Mixing*, Palermo (Italy) (Mar. 17-21, 1958), London, Pergamon Press, 1958, p. 118-152.

Recent theoretical and experimental work on mixing flows is reviewed. Two general problems are discussed: (1) the free mixing of semi-infinite streams, and (2) mixing in the presence of a wall. In the first problem there are considered the cases of uniform streams and of non-uniform streams involving separately streamwise pressure gradients and vorticity. The fully developed free

PIB.12:012; PIB.13:001, 002

turbulent mixing of two different gases is discussed; in particular the governing equations for two different assumptions with respect to turbulent transport are derived. Solutions for unity values of turbulent Prandtl and Schmidt numbers and for a parabolic density-velocity relationship have been obtained by high-speed machine calculations. On the basis of the numerical results it is concluded that turbulent mixing velocity profiles are substantially independent of the nature of the gases, of the free stream density ratio and of the Mach numbers. Approximate solutions in these types of non-homogeneous turbulent mixing are presented. The possibility of one-parameter solutions of homogeneous compressible laminar mixing in the presence of streamwise pressure gradients is shown and the pertinent equations are derived. The influence of outer vorticity on the characteristics of the laminar or turbulent interaction of an incompressible, constant-vorticity stream with fluid at rest is determined. In the second problem, the various regions of the interaction between the mixing region and the boundary layer on the wall are discussed. For the first region, wherein an inviscid core between the two viscous regions exists, a solution is presented. Preliminary results of an experimental investigation of compressible, isoenergetic mixing in the presence of a wall are also presented. (Contractor's abstract)

PIB.12:012

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

A REVIEW OF SOME RECENT DEVELOPMENTS IN HYPERSONIC FLOW, by A. Ferri. [1958] [45]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-217 and WADC Aeronautical Research Lab. under AF 33-(616)3265) Unclassified

Presented at First Internat'l. Congress for the Aeronautical Sciences, Madrid (Spain) Sept. 8-13, 1958.

Also published in *Advances in Aeronaut. Sciences*, v. 2: 723-770, 1959.

This review indicates the following conclusions: (a) The results of theoretical work and of experiments involving simulation of flight conditions tend to indicate that in the approximation within which the physical quantities can be determined and for high flight Reynolds number real gas effects are of relatively small importance. (b) Pressure distributions and forces on simple boundary conditions can be obtained with simple rough approximations, with accuracy often sufficient for engineering applications. More appreciable progress is required in the development of approximate analyses for more complicated boundary conditions or of more precise analyses for simple problems. (c) The heat transfer on simple bodies can be obtained with good approximation for the laminar case from existing theories. Simple

theories for turbulent cases seem to give sufficient approximation. However, transition phenomena and the foundation of turbulent analysis require much further study. (d) Entropy gradients can affect heat transfer an appreciable amount and can be utilized to reduce aerodynamic heating at high speed.

PIB.13:001

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

TORSION OF CYLINDRICAL AND PRISMATIC BARS IN THE PRESENCE OF PRIMARY CREEP, by S. A. Patel and K. A. V. Pandalai. Apr. 1958 [7]p. incl. diagrs. (PIBAL rept. no. 417) (AFOSR-TN-58-303) (AF 49-(638)302) AD 154213; PB 134662 Unclassified

The creep problem treated in this article has been shown to reduce to the non-linear elastic problem where

the material is governed by the equation: $\epsilon_{ij} = D J_2^a s_{ij}$

where ϵ_{ij} is the strain tensor, s_{ij} the stress-deviation

tensor, and D and a are material constants. The elastic solution for the torsion of cylindrical and prismatic bars is given by Patel, Venkatraman and Hodge (Torsion of Cylindrical and Prismatic Bars in the Presence of Steady Creep, presented at the annual meeting of the annual ASME Meeting, New York, Dec. 1957). The results for the angle of twist per unit length α for a given torque T are obtained for the case of a cylindrical bar of circular cross-section, as well as for cross sections which are regular polygons and triangles of unequal sides. By employing the principle of minimum total potential and the principle of minimum complementary potential, upper and lower bounds on α were obtained. However, an exact solution could be obtained for the case of circular cross-section for which the warping function vanishes. (Contractor's abstract)

PIB.13:002

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

ON ASYMPTOTIC NUMERICAL METHODS FOR PARABOLIC EQUATIONS, by J. R. M. Radok. Nov. 1958, 14p. [PIBAL rept. no. 485] (AFOSR-TN-58-1072) (AF 49-(638)302) AD 207241 Unclassified

Investigation of the roles played in the partial differential equations of physics by time and space derivatives leads to the conclusion that divided differences render suitable approximations to space derivatives, while the approximation of time derivatives may greatly benefit from more refined treatment. The formerly developed method of exponential extrapolation is applied to the diffusion equation for which explicit and implicit schemes are deduced. Based on certain assumptions, it is shown that the

PIB.13:003; PIB.07:006-008

stability range for the explicit scheme becomes infinite as the steady state is approached. This result may lead to considerable savings of machine time in practical applications of the method. (Contractor's abstract)

PIB.13:003

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

STRESS DISTRIBUTION IN MULTI-CELLULAR TORQUE BOXES DUE TO PRIMARY AND SECONDARY CREEP, by K. A. V. Pandalai and S. A. Patel. Dec. 1958 [28]p. incl. diagrs. tables. (PIBAL rept. no. 480) (AFOSR-TN-58-1074) (AF 49(638)302) AD 207243; PB 138510 Unclassified

The stress analysis of multicellular torque boxes in the presence of primary as well as secondary creep is discussed. The elastic analog is used to reduce the creep problem to one of nonlinear elasticity. The results indicate that depending upon the geometry of the structure the stress distribution can differ appreciably from that given by linear theory. Furthermore, the deformation caused by creep can be significant. (Contractor's abstract)

PIB.07:006

Polytechnic Inst. of Brooklyn. Dept. of Chemistry, N. Y.

LIGHT INDUCED SPECTRAL SHIFT OF THE THIAZINE DYES IN THE BOUND STATE, by N. Wotherspoon and G. Oster. [1957] [4]p. incl. diagrs. table. (AF 18(600)1182) Unclassified

Published in Jour. Amer. Chem. Soc., v. 79: 3992-3995, Aug. 5, 1957.

The authors have found that thiazine dyes in the presence of polymethacrylic acid or polyacrylic acid undergo a spectral shift when irradiated with visible light. A combined recording spectrophotometer and irradiation apparatus was used to follow the reaction either at a fixed wave length or by scanning the spectrum repetitively. Two photo products are formed, one in the absence of oxygen and the second by the photooxidation of the first. The rate of formation of the second product is retarded by small amounts of paraphenylenediamine or by potassium iodide suggesting that long-lived excited states are involved. The final photoproduct is the same for all the thiazine dyes studied and is identical to thionine. The reaction requires a polyacrylic acid but does not take place in the presence of other high polymeric acids or of dibasic acids. (Contractor's abstract)

PIB.07:007

Polytechnic Inst. of Brooklyn. Dept. of Chemistry, N. Y.

PHOTOREDUCTION OF METHYLENE BLUE BY ETHYLENEDIAMINETETRAACETIC ACID, by G. Oster and N. Wotherspoon. [1957] [3]p. incl. diagrs. refs. (AF 18(600)1182) Unclassified

Published in Jour. Amer. Chem. Soc., v. 79: 4836-4838, Sept. 20, 1957.

Methylene blue in the presence of ethylenediaminetetraacetic acid (EDTA) is reduced to the leuco dye on irradiation with red light. The rate of photoreduction depends upon pH in the same way as does the base titration of EDTA. EDTA is consumed in the reaction suggesting that it is oxidized although it does not normally function as a reducing agent. A number of nitrogen-containing chelating agents were tested but only those with secondary or tertiary nitrogens behaved as electron donors in the photochemical reaction. The photoreduction involves a long-lived excited state of the dye (10^5 times that of the first electronically excited state) and is retarded by small amounts of p-phenylenediamine. The rate of regeneration of the dye by near ultraviolet irradiation of the leuco form increases with increasing hydrogen ion concentration. (Contractor's abstract)

PIB.07:008

Polytechnic Inst. of Brooklyn. Dept. of Chemistry, N. Y.

PHOTOREDUCTION OF ACRIDINE DYES, by F. Millich and G. Oster. [1958] [35]p. incl. diagrs. table, refs. (AFOSR-TN-58-836) (AF 18(600)1182 and AF 19(603)-3065) AD 202921 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 1357-1363, Mar. 20, 1959.

A number of acridine dyes in the presence of allylthiourea are reduced to their leuco forms on irradiation with blue light. Those acridines which have amino substituents in both the 3- and 6-position undergo photoreduction rapidly. Another group of acridines undergoes photoreduction at one tenth the rate of the first and a third group exhibits no reactivity. A correlation exists between phosphorescence of the dyes and their ability to undergo photoreduction. The detailed kinetics of photoreduction of proflavin at its pH for maximum rate, namely, pH 4, coupled with fluorescence studies showed that: (a) the reduction proceeds through a long-lived excited state, (b) the transition from the first singlet excited state to the long-lived state is induced by dye molecules in the ground state, (c) the inductive forces of interaction act over distances of 500 Å. (Contractor's abstract)

PIB.07:009; PIB.14:001;
PIB.15:001, 002

PIB.07:009

Polytechnic Inst. of Brooklyn. [Dept. of Chemistry] N. Y.

PHOTOREDUCTION OF DYES, by G. Oster. Final rept. June 1, 1954-May 31, 1958. [17]p. incl. table, refs. (AFOSR-TR-58-69) (AF 18(600)1182) AD 158280
Unclassified

The kinetics of photoreduction of dyes in the presence of electron donors for the excited dyes has been studied in detail. The dyes examined include members of the fluorescein, thiazine, triphenyl methanes (bound to high polymers), and the acridines. In all cases it was established that long-lived excited states are involved. It is in this state that the dye abstracts electrons from the reducing agent to give the reduced (leuco) dye. The long-lived state has a life time about 10^5 times greater than the excited singlet state. Dyes in the bound state and proflavine in the free state show an increase in quantum yield with an increase in concentration of dye. This is accompanied by a self-quenching of fluorescence. These results are probably due to dye induced conversion of the singlet to the triplet (long-lived) states. The relation of photoreduction to dye-sensitized photoautoxidations is described. Applications of the work are outlined. (Contractor's abstract, modified)

PIB.14:001

Polytechnic Inst. of Brooklyn. Dept. of Chemistry, N. Y.

PHOTOREDUCTION OF DYES IN RIGID MEDIA. I. TRIPHENYLMETHANE DYES, by G. Oster, J. Joussot-Dubien, and B. Broyde. [1958] [4]p. incl. diagrs. refs. (AFOSR-TN-58-1051) (AF 49(638)293) AD 206985
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 88: 1869-1872, Apr. 20, 1959.

Certain triphenylmethane dyes can be photoreduced when incorporated in glucose glasses, whereas the same dyes in aqueous solutions of glucose are unaffected by light. All triphenylmethane dyes become increasingly more fluorescent the greater the viscosity of the medium. In the case of the dyes which are photoreducible in glucose glass, however, superposed on room temperature fluorescence is an α -phosphorescence (delayed fluorescence). In the more rigid glasses the phosphorescence lifetime was found to decrease with increasing temperature but to be practically independent of viscosity. The rate of photoreduction of acid fuchsin in glucose as a function of temperature is maximal at about 60°. The kinetic and spectral data suggest that three processes must be considered: (1) the suppression of internal conversion of the single excited state to the ground state by increasing the viscosity of the medium, (2) the transitions from the metastable state to the ground state, (3) the reaction between dye molecules in the metastable state and glucose. The first process is

favoured by lowering the temperature, whereas the reverse is the case for the latter two processes.

PIB.15:001

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

A NEW THEORY OF ELASTIC SANDWICH PLATES. ONE-DIMENSIONAL CASE, by Y.-Y. Yu. [Oct. 1958] 25p. incl. diagrs. table. [Technical note no. 1] (AFOSR-TN-58-896) (AF 49(638)453) AD 204133
Unclassified

The 1-dimensional case is presented of a new flexural theory of isotropic elastic sandwich plates deduced from the theory of elasticity. The theory includes the effects of transverse shear deformation and rotatory inertia in both the core and faces of the sandwich, and no limitations are imposed upon the magnitudes of the ratios between the thicknesses, material densities, and elastic constants of the core and faces of the sandwich. The method used is an extension of one used by Mindlin, and the results reduced to those of his for the corresponding homogeneous plates as special limiting cases. A final equation may also be simplified and reduced to the corresponding results of Reissner (NACA report 975, 1950), and Hoff (NACA Tech. note 2225, 1950) for the bending of ordinary sandwich plates that have thin faces. Results of the theory are applied to the problem of bending of a cantilever plate subjected to load at the unsupported end, and to the problem of propagation of straight-crested waves in an infinite plate.

PIB.15:002

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

SIMPLE THICKNESS-SHEAR MODES OF VIBRATION IN INFINITE SANDWICH PLATES, by Y.-Y. Yu. [Oct. 1958] 15p. incl. tables. [Technical note no. 2] (AFOSR-TN-58-897) (AF 49(638)453) AD 204132
Unclassified

Closed-form solutions are obtained for simple thickness-shear modes of free vibration of infinite sandwich plates from the exact elasticity theory. The antisymmetric mode is further solved according to the new flexural theory of sandwich plates presented in a companion paper. By matching the lower frequency calculated from the sandwich-plate theory with the corresponding fundamental frequency from the elasticity theory, the value of a shear coefficient in the sandwich-plate theory may be determined directly. It is shown that, for sandwich plates, the shear coefficient is not constant and may have a value very close to unity, in contrast to its constant value of $\pi^2/12$ for homogeneous plates given by Mindlin (Jour. Appl. Mech., v. 18: 31-38, 1951). (Contractor's abstract)

PIB.09:010 - PIB.09:014

PIB.09:010

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

THE SCATTERING MATRIX IN NETWORK THEORY, by H. J. Carlin. [1956] [10]p. incl. diagrs. refs. [AF 18(600)1505] Unclassified

Published in I.R.E. Trans. of Professional Group on Circuit Theory, v. CT-3: 88-97, June 1956.

An introductory treatment of the concept and uses of scattering methods in network problems is described. The scattering parameter description for linear networks is defined and the utility of this formalism for problems involving power flow in terminated networks is discussed. Examples of scattering computations for transformer 4-ports, transformerless impedance-matching networks and transducers with parasitic capacitance are given. The physical realizability requirements for linear lumped networks in the frequency domain are presented in scattering terms, and some extensions to the realizability of distributed networks are briefly discussed.

PIB.09:011

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

ON FIELD REPRESENTATIONS IN TERMS OF LEAKY MODES OR EIGENMODES, by N. Marcuvitz. [1956] [3]p. [AF 18(600)1505] Unclassified

Presented at Internat'l. Symposium on Electromagnetic Wave Theory, Ann Arbor, Mich., June 20-25, 1955.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-4: 192-194, July 1956.

Solutions to source-excited field problems are frequently represented as superpositions of source-free field solutions. The latter are in general of two types: eigenmodes and noneigenmodes which are related to the zeros of the total impedance or alternatively the poles of the scattering coefficient of a system. The eigenmodes are everywhere finite and comprise a complete orthogonal set. The noneigenmodes become infinite in the infinitely remote spatial limits of a region and are not in general members of a complete orthogonal set; examples are "radio-active states," "damped resonances," and "leaky waves." Despite their physically singular behavior, the nonmodal solutions can be employed to represent field solutions in certain ranges. (Contractor's abstract)

PIB.09:012

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

ON ELECTROMAGNETIC-SPACE CHARGE MODES, by G. H. Joshi and N. Marcuvitz. Aug. 29, 1956, 10p. (Rept. no. R-521-56) (AF 18(600)1505) Unclassified

The interaction of an electromagnetic field with an electron beam is basic to the operation of many structures employed for the generation and amplification of microwave power. Such a coupled system serves as a wave propagator and is describable in terms of a set of modes that constitute a generalization of those normally encountered in conventional waveguides with perfectly conducting boundaries. Preliminary work on the determination of the nature and orthogonality properties of such modes is reported.

PIB.09:013

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

ON PLASMA OSCILLATIONS, by B. A. Lippmann. Dec. 26, 1956, 4p. (Rept. no. R-544-56) (AF 18(600)1505) Unclassified

It is shown that the plasma dispersion relation can be deduced from the assumption that we are dealing with the longitudinal motion of an electrically neutral, polarizable fluid. It follows that if the dispersion law is to be valid for a system of charged particles we must have: (a) electrical neutrality in the mean; (b) a particle density high enough to justify the passage from a discrete set of particles to a hydrodynamic fluid; and, (3) fields that vary slowly enough in space and time for the Lorentz equations to be replaced by the Maxwell equations.

PIB.09:014

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

SPACE CHARGE PROBLEMS IN MICROWAVE ELECTRON TUBES, by G. Mourier. Dec. 27, 1956, 7p. (Rept. no. R-546-56) (AF 18(600)1505) Unclassified

An experimental and theoretical program for the study of space charge phenomena in electron tubes with crossed electric and magnetic fields is described. Such a field configuration is of the type used in magnetrons and some traveling-wave tubes and is generally referred to as "M-type". A systematic study of space charge effects in M-type carcinotrons and forward - or backward-wave amplifiers would provide a better understanding

of these phenomena and their influence on efficiency and performance. This is of particular interest where space charge effects are pronounced as in high power tubes.

PIB.09:015

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

THE APPLICATION OF MAXIMUM-LIKELIHOOD TECHNIQUES TO SEVERAL PROBLEMS IN COMMUNICATION THEORY, by D. [C.] Youla. Oct. 23, 1956 [25]p. incl. diagr. (Research rept. no. R-524-56; PIB-454) (AFOSR-TN-57-28) (AF 18(600)1505) AD 115063

Unclassified

In this report the technique of "Maximum Likelihood" is applied to two distinct problems with engineering significance. The first problem may be stated as follows: Suppose that the received datum in $0 \leq t \leq T$ is given by $e(t) = \sigma x(t)$, where $x(t)$ is Gaussian, and σ is unknown but constant over the observation interval. Then it is shown that with probability one σ may be determined exactly from any one realization of $x(t)$ independent of T . The method requires an infinite sampling scheme. In addition, any method using N samples possesses a percentage inaccuracy $\approx \sqrt{2}/N$. An explicit representation is given for the sampling procedure which attains the lower bound. The results are applied to several cases involving power measurement. The second problem is concerned with the demodulation of information when both additive noise and fading (of a special type) are present. It is pointed out that the resulting integral equations imply a closed-loop type of servo-system with internal automatic gain control. Possible mechanization schemes are discussed.

PIB.09:016

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

SYNTHESIS OF ACTIVE RC TRANSFER FUNCTIONS, by I. M. Horowitz. Nov. 8, 1956, 85p. incl. diagrs. refs. (Research rept. no. R-507-56; PIB-437) (AFOSR-TN-57-74) (AF 18(600)1505) AD 120417

Unclassified

This report presents new methods of synthesis of stable active RC transfer functions in the form of unbalanced two terminal-pair networks. The philosophy leading to these methods is the representation of active RC networks by means of positive and negative RC elements. Modern passive synthesis procedures are thereby made available. The outstanding features of the synthesis techniques are: (1) they are exact in that the active elements are not idealized with respect to input and output impedance, (2) emphasis throughout is on methods and configurations which lead to practical structures involving transistors or tubes; and (3) the relations between

the gain, the sensitivity and the character of the transfer function are developed. The designer knows how to make the transfer function insensitive to circuit parameters and the price paid in gain and impedance level. The complex pole synthesis problem is divided into two classes. One class consists of those problems resolvable into separate RC and RL syntheses. The RL synthesis is achieved by means of resistors, capacitors and transistors or tubes. In many cases one transistor or tube suffices. The second class of complex pole functions involves the synthesis of a negative RC immittance. Several synthesis procedures are developed for this purpose. Two general synthesis techniques are presented for the unrestricted realization of transmission zeros. One of these is an active RC ladder development in canonical sections in the tradition of Brune, Darlington, and Dasher. The other method involves the realization of a transfer function with unrestricted zeros and negative real poles by means of an RC network in parallel with a transistor. The methods derived for pole and zero realization are combined for the general solution of transfer function problems. (Contractor's abstract)

PIB.09:017

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

THE SHEATH-HELIX PARAMETER KQ FOR $n = 1$ MODE, by I. Sugai. Feb. 7, 1957 [16]p. incl. diagrs. (Research rept. no. R-554-57; PIB-482) (AFOSR-TN-57-75) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1505, Office of Naval Research, and Signal Corps Engineering Labs.) AD 120418

Unclassified

For the modes with angular variation $\exp(-jn\theta)$ in a sheath-helix, the surface admittance presented to a thin hollow electron beam either inside or outside of the helix is derived for the general n -th mode in an exact form. Useful approximations are given for Pierce's K impedance. This approximation is very similar to previously obtained expressions. It has sometimes been thought that the values of KQ for $n = 1$ and $n = 0$ are equal. They are found to be fairly different for both positions of the electron beam except for $\nu_a = 5$.

PIB.09:018

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

BACKLASH AND HYSTERESIS EFFECTS IN AUTOMATION SYSTEMS, by L. M. Vallese. Aug. 22, 1957 [10]p. incl. diagrs. (Rept. no. R-602-57; PIB 530) (AFOSR-TN-57-580) (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under AF 18(600)1505) AD 136568

Unclassified

The problem of the analysis of the limits of stability of

PIB.09:019 - PIB.09:023

feedback control systems involving backlash or hysteresis was investigated by application of a time domain procedure that may be considered derived from that of N. Kryloff and N. Bogoliuboff (Introduction to Non Linear Mechanics. Princeton U. Press, 1942). This procedure provides analytical rather than graphical solutions for the amplitude and the frequency of the possible sustained oscillations. Examples of application to second and third order systems are shown.

PIB.09:019

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

A TRANSIENT ANALYSIS OF A BISTABLE MAGNETIC AMPLIFIER, by A. Aronowitz. July 10, 1957 [44]p. incl. illus. diagrs. tables. (Rept. no. R-592-57; PIB-520) (AFOSR-TN-57-593) (AF 18(600)1505) AD 136579
Unclassified

The effect was investigated of the circuit parameters on the response time of a bistable magnetic amplifier. A detailed examination of the diode bridge is made, and from this all pertinent circuit equations are derived. From these equations, the core fluxes are solved as functions of time, for three half cycles of the transient. The relative magnitudes of the circuit parameters that minimize the transient time are then deduced. In conclusion, two relations for the circuit parameters are presented. When the first is satisfied, the transient time required to switch the amplifier from its "off" to "on" condition is minimized to two half cycles. When the second is satisfied, the transient time required to switch the amplifier from its "on" to "off" condition is minimized to three half cycles. (Contractor's abstract)

PIB.09:020

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

ZERO STATES OF HERMITIAN OPERATORS IN FINITE DIMENSIONAL SPACES, by P. Parzen. Jan. 22, 1957, 7p. (Rept. no. R-630-57; PIB-558) (AF 18(600)-1505)
Unclassified

Zero states for a general Hermitian matrix are constructed. In the two dimensional cases it is shown that Hermitian matrices with the same zero states are similar.

PIB.09:021

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

POWER GAIN AND PROPAGATION CONSTANTS IN

TRAVELING WAVE TUBES, by G. Mourier and I. Sugai. Mar. 1, 1957, 6p. (Rept. no. R-561-57) (AF 18(600)1505)
Unclassified

Though the existence of power gain in forward wave traveling wave tubes is generally believed to be associated with exponentially growing waves, it will be shown here that it is also obtained in conditions where each wave has a constant amplitude along the circuit. This tends to emphasize the importance of the phase relationship between the total electronic current and the total field rather than that of the nature of the propagation constants, as already indicated by the theory of the carcinotrons, O-type as well as M-type. The "non-exponential gain" found here depends critically upon the initial conditions at the input of the circuit, but it is a wide band phenomenon and, in fact, it increases the bandwidth of tubes, especially of low gain tubes as the M-type amplifier has been so far. It can pose problems in applications where the filterlike properties of the tubes are used. The study is done here on the simplest case algebraically speaking, the M-type amplifier, but the nature of the results is believed to be more general. Cold attenuation is not taken into consideration.

PIB.09:022

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

SURFACE WAVES IN ELECTRONIC WAVEGUIDES, by G. Mourier. Mar. 25, 1957, 9p. (Rept. no. R-587-57; PIB-495) (AF 18(600)1505)
Unclassified

Electronic waveguides have been studied under the assumption that an infinite longitudinal magnetic field prevents transverse motion of the electrons. Considered here is the case of no focusing magnetic field. In practice, this new assumption is realistic only in very few cases: if the dc space charges were neutralized by positive ions trapped in the beam, no external focusing force would be needed, and, neglecting the ac motion of the ions in regard to their large mass as well as collisions, one would have to consider only the electron motion without magnetic force. In some cases too, a drift tube will be short and no magnetic field will be required. We consider a smooth waveguide of any cross section partly filled by an electron beam moving along the guide.

PIB.09:023

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

INSTABILITY IN THIN ELECTRON BEAMS, by G. Mourier. Apr. 3, 1957, 18p. (Rept. no. R-570-57; PIB-498) (AF 18(600)1505)
Unclassified

Space charge phenomena in electron beams have been studied in conditions where the transverse dimensions

PIB.09:024 - PIB.09:027

of the beam are not negligible. A very simplified description of the phenomena that have been analyzed is that electrons oscillate inside the beam around some stable position which drifts with the electron stream. In practical tubes where these phenomena occur, the transverse dimensions of the beam are commensurate with the "waveguide" wavelength, itself of the order of $\lambda v/c$.

the constants C_r , α_r , β_r , and γ_r being linked together by the integral equation. It is precisely the labor involved in their determination that in practice often causes the problem to assume awesome proportions. By means of the results given herein, this labor is diminished to the irreducible minimum—the solving of a transcendental equation. (Contractor's abstract)

PIB.09:024

Polytechnic Inst. of Brooklyn. [Microwave Research Inst., N. Y.

ON THE EFFECT OF LOSSY WALLS ON GROWING SPACE CHARGE WAVES IN CROSSED FIELDS, by G. Mourier. June 17, 1957, 7p. (Rept. no. R-589-57; PIB-517) (AF 18(600)1505) Unclassified

It is shown that oscillations due to a circuit resonance interacting with an M-type beam can be avoided by using a lossy anode or sole.

PIB.09:025

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

THE SOLUTION OF A HOMOGENEOUS WIENER-HOPF INTEGRAL EQUATION OCCURRING IN THE EXPANSION OF SECOND-ORDER STATIONARY RANDOM FUNCTIONS, by D. C. Youla. [1957] [7]p. incl. refs. (AF 18(600)1505) Unclassified

Published in I.R.E. Trans. of Professional Group on Information Theory, v. IT-3: 187-193, Sept. 1957.

In many of the applications of probability theory to problems of estimation and detection of random functions an eigenvalue integral equation of the type

$$\psi(x) = \lambda \int_0^T K(x-y)\psi(y)dy, \quad 0 \leq x \leq T,$$

is encountered where $K(x)$ represented the covariance function of a continuous stationary second-order process possessing an absolutely continuous spectral density. In this paper an explicit operational solution is given for the eigenvalues and eigenfunctions in the special but practical case when the Fourier transform of $K(x)$ is a rational function of ω^2 , i.e.,

$$K(x) = G(s^2) \frac{N(s^2)}{D(s^2)}, \quad s = i\omega,$$

in which $N(s^2)$ and $D(s^2)$ are polynomials in s^2 . It is easy to show by elementary methods that the solutions are of the form

$$\psi(x) = \sum_r C_r e^{-\alpha_r x} \cos(\beta_r x + \gamma_r),$$

PIB.09:026

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

ORTHOGONALITY PROPERTIES FOR MODES IN PASSIVE AND ACTIVE UNIFORM WAVEGUIDES, by A. D. Bresler, G. H. Joshi, and N. Marcuvitz. Dec. 5, 1957 [19]p. (Rept. no. R-625-57; PIB-553) (AFOSR-TN-58-29) (AF 18(600)1505) AD 148068 Unclassified

Also published in Jour. Appl. Phys., v. 29: 794-799, May 1958.

Orthogonality relations are given for the "four-vector" guided modes of anisotropic uniform waveguides and for the "six-vector" guided modes of uniform waveguides containing unidirectional electron beams with axially independent dc velocities. In general, these orthogonality relations involve both the modes of the given waveguide and those of an appropriate "adjoint" waveguide. A description is given for the adjoint waveguides associated with waveguides which contain media whose characteristics are restricted only by the requirement that they be axially independent and which, if bounded, are subject to a variety of boundary conditions arising from idealization of actual boundaries.

PIB.09:027

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

EXTRACTION OF ROOTS BY REPEATED SUBTRACTIONS FOR DIGITAL COMPUTERS, by I. Sugai. Feb. 10, 1958, [22]p. incl. diagrs. tables, refs. (Rept. no. R-640-57; PIB-568) (AFOSR-TN-58-317) (AF 18(600)1505) AD 154221 Unclassified

Extraction of roots of any real number is obtained as the result of repetitive subtractions. Special number elements formed by $m^n - (n-1)^n$, n = any positive integer, $m = 1, 2, 3, \dots, 9, 10$, are used for $x^{1/n}$, where x is any real number. This method is applicable for a large number of digit places, so far as computers can handle them by multiple-precision arithmetic. As a guide for the general n -th order extraction of roots, the program and coding are given for the cube root. (Contractor's abstract)

PIB.09:028 - PIB.09:032

PIB.09:028

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

PROCEEDINGS OF THE SYMPOSIUM ON THE ROLE OF SOLID STATE PHENOMENA IN ELECTRIC CIRCUITS, NEW YORK, Apr. 23-25, 1957, Vol. VII, ed. by J. Fox and M. Crowell. N. Y., Interscience Publishers, 1957, 339p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-39) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [AF 18(600)1505]) Unclassified

Topics discussed in this symposium include a general introduction to the physical phenomena and circuit aspects of solid state phenomena, a discussion of the vesitron, the maser and ferroelectrics in general, as well as organic plastics and devices using InSb. Papers grouped under the headings: (1) semiconductor properties and techniques; (2) magnetic properties and techniques; and (3) photo-techniques are presented in the last three sessions.

PIB.09:029

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

GENERAL ELECTRONIC WAVEGUIDES, by N. Marcuvitz. [1958] [25]p. incl. diagrs. (AF 18(600)1505) Unclassified

Published in Proc. Symposium on Electronic Waveguides, Polytechnic Inst. of Brooklyn, N. Y. (Apr. 8-10, 1958), N. Y., Interscience Publishers, 1958, p. 63-87.

Different analyses of propagation and diffraction problems in traveling-wave-tube, plasma, and other anisotropic structures are contrasted. Application of conventional guided wave theory to electron and ion beam loading in such electronic waveguide regions leads to an analysis in terms of the "cold modes" of the unloaded structure. Difficulties and advantages of this perturbation procedure are discussed. An alternative analysis in terms of orthogonal "hot modes", the use of transverse resonance techniques for hot mode determinations, and the relation to problems of diffraction at "hot discontinuities" is presented. (Contractor's abstract)

PIB.09:030

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

PROCEEDINGS OF THE SYMPOSIUM ON ELECTRONIC WAVEGUIDES, NEW YORK, Apr. 8-10, 1958, Vol. VIII, ed. by J. Fox and M. Crowell. N. Y., Interscience Publishers, 1958, 418p. incl. illus. diagrs. tables, refs.

(Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [AF 18(600)1505]) Unclassified

Topics discussed in this symposium include 2 and 3 level masers, plasmas and plasma oscillations in waveguides, backward waves and O-type backward-wave oscillators, double stream electron wave systems, electron noise in waveguides, the conversion of space-charge wave energy into electromagnetic radiation, and the observations of plasma and cyclotron oscillations. A fundamental formulation of the interactions of electron waveguides is given in differential form which can be used for computers directly. Papers on the interactions between an electron stream and an arc discharge plasma, and high magnetic field submillimeter wave generators with paramagnetic excitation are included.

PIB.09:031

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

DIELECTRIC CONSTANT AND RESISTIVITY OF INTRINSIC AND LIGHTLY-DOPED n-TYPE GERMANIUM AT 9.4 Kmc, by M. Birnbaum. June 26, 1958 [9]p. incl. diagr. tables. (Rept. no. R-673-58; PIB-601) (AF 18(600)1505) Unclassified

The effective mass of electrons in lightly doped n-type germanium has been determined by means of dielectric constant measurements at 9.4 kmc. At 300°K, the electron effective mass obtained is $0.15 \pm 0.07 m_e$. The dielectric constant for intrinsic Ge at room temperature was found to be 16.15 ± 0.11 . (Contractor's abstract)

PIB.09:032

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

SYNTHESIS OF OPTIMUM PHASE-LEAD COMPENSATED SECOND ORDER FEEDBACK CONTROL SYSTEM, by C. Davidson. Sept. 29, 1958 [17]p. incl. diagrs. (Rept. no. R-690-52; PIB-618) (AF 18(600)1505) Unclassified

The purpose of this report is to study the properties of phase-lead compensated second order feedback control systems and to show how to synthesize the closed-loop transfer function of the system, starting with specifications for bandwidth, maximum overshoot, and generalized error constants. These specifications are used in the Guillemin-Truxal synthesis. Attempt is made to find a pure synthesis approach; to construct "synthesis diagrams" from which all unknown parameters can be determined immediately, eliminating a trial and error procedure. Further, because an infinite set of parameter values always satisfies the specifications, if these can be

PIB.09:033; PIB.10:003-005

satisfied at all, the "optimum" configuration is desired. Attention is also given to the linear and nonlinear limitations of the system. Finally, the second step in the system design, the determination of open-loop transfer functions, is discussed briefly. (Contractor's abstract, modified)

PIB.09:033

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

PLASMA PROGRAM (Abstract), by N. Marcuvitz. [1958] [2]p. (Bound with its AFOSR-TR-58-125; AD 162274) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under AF 18(600)1505; Air Force Office of Scientific Research under AF 49(638)340; and Air Force Cambridge Research Center under AF 19(604)2031) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The plasma program is directed both toward understanding the basic properties of plasmas in the low to medium density range and producing carefully controlled plasmas in these ranges. The effort is devoted on the one hand to the study of wave types and instabilities associated with relatively high current density electron beams in crossed fields and on the other to more direct investigations of electronic behavior and wave types in plasmas produced by high current discharges in Ne and H₂.

The experimental program is supplemented by related studies of transport processes in plasmas and wave phenomena resulting from electromagnetic field-charged particle interactions particularly in the microwave range.

PIB.10:003

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

MULTISECTION MICROWAVE TERMINATING STRUCTURES, by L. Coltun. Apr. 24, 1957, 1v. incl. diagrs. (Rept. no. R-573-57; PIB-501) (AFOSR-TN-57-286) (AF 18(603)105) AD 132357 Unclassified

Analysis and methods of design are presented for several special broadband transmission line terminating structures. Each is characterized by a tandem connection of subdivisions called "unit cells"-where each cell consists, in general, of a lossy shunt admittance and several lossless transmission lines having nonferrous dielectrics. An approach toward broadband structures of shorter lengths is described in which the input admittance to each cell is real at the center frequency of design.

PIB.10:004

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

SCATTERING MATRICES AND THE FOUNDATIONS OF LINEAR, PASSIVE NETWORK THEORY, by D. C. Youla, L. J. Castriota, and H. J. Carlin. Sept. 10, 1957 [72]p. incl. diagrs. refs. (Rept. no. R-594-57; PIB-522) (AFOSR-TN-57-581) (AF 18(603)105) AD 136569

Unclassified

This report is concerned with the construction of a rigorous theory of linear passive networks from the point of view of energy conservation and causality. It is shown that five postulates defining the physical nature of a network suffice to give all analytic properties of the network scattering matrix $S(z)$ (z is the complex frequency variable $\omega + i\beta$). These analytic properties define a bounded real scattering matrix, the possession of which is necessary and sufficient for an n -port network to satisfy physical realizability as stated by these postulates. A bounded real scattering matrix is analytic and bounded in the strict upper half of the z plane, and has an associated form $Q(z) = I_n - \bar{S}^T(z) S(z)$ which is the matrix of a positive hermitian form in this region. An alternate formulation of the bounded real property is given which stresses boundary behavior of $S(z)$ and $Q(z)$. These analytic properties of $S(z)$ lead to a generalized formulation of a positive real immittance matrix. A theorem concerning the necessary and sufficient conditions for the existence of a Faltung-representation is proved and its implications discussed. The entire treatment is mathematical in nature and leans heavily on the theory of linear bounded operators.

PIB.10:005

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

DIFFERENTIAL PROPERTIES AND SENSITIVITY OF ROOT LOCI, by H. Ur. Nov. 21, 1958, 24p. incl. diagrs. refs. (Rept. no. R-697-58; PIB-625) (AF 18(603)105) Unclassified

The differential properties of root loci, including pole sensitivity, angle of slope and curvature of the locus, are investigated in a unified manner. The locus is treated as a transformation of a line (the real axis) in the K plane to the s plane and properties of analytic functions are used to simplify calculations and results. It is shown that all results apply to the general root locus of a non real K . (Contractor's abstract)

PIB.16:001; POM.01:005-008

PIB.16:001

Polytechnic Inst. of Brooklyn, Microwave Research Inst.,
N. Y.

ON THE THEORY OF M-TYPE TUBES WITH THICK BEAMS, by G. Mourier. Aug. 22, 1958, [16]p. incl. diagrs. refs. (Rept. no. R-680-58; PIB-808) (AFOSR-TN-58-926) (AF 49(638)340) AD 204738; PB 147446
Unclassified

The effects of space charge in crossed-field, M-type, tubes is considered qualitatively. The consideration of 2 surface waves associated respectively with the upper and lower boundaries of the beam make possible a broad understanding of the behavior of M-type tubes with thick, heavy-current beams. No systematic comparison of theory with experiments is made. However, the gain calculation seems to be in general agreement with experiment, as is the prediction of a minimum efficiency for intermediate values of beam current. The most serious restriction on this analysis is probably the assumption of laminar flow. (Contractor's abstract)

POM.01:005

Pomona Coll. Dept. of Physics, Claremont, Calif.

ULTRASOFT X-RAY PHYSICS AND APPLICATIONS, by B. L. Henke. Summary technical rept. June 1957 [38]p. incl. illus. diagrs. refs. (AFOSR-TN-57-436) (AF 18(600)1045) AD 136426; PB 151182
Unclassified

This report is made up of the following reports and are abstracted separately: (1) Ultrasoft X-ray Analysis of Micron Systems, by B. L. Henke; (2) Submicroscopic Structure Determination by Long Wavelength X-ray Diffraction, by B. L. Henke and J. W. M. DuMond (POM.01:001); (3) Tables for the Computation of Intensity Distribution Functions for Isotropic, Non-Absorbing Spheres, by J. C. Miller; (4) Semiempirical Determination of Mass Absorption Coefficients for the 5 to 50 Angstrom X-ray Region, by B. L. Henke, R. White, and B. Lundberg; (5) Monochromatic Sources of Ultrasoft X-radiation for Quantitative Microradiographic Analysis, by B. L. Henke; (6) Conditions for Optimum Visual and Photometric "Contrast" in Microradiograms, by B. L. Henke, B. Lundberg, and A. Engström; and (7) Slide Rule for Radiographic Analysis, by B. Lundberg and B. L. Henke (POM.01:004).

POM.01:006

Pomona Coll. Dept. of Physics, Claremont, Calif.

CONDITIONS FOR OPTIMUM VISUAL AND PHOTOMETRIC "CONTRAST" IN MICRORADIOGRAMS, by

B. L. Henke, B. Lundberg, and A. Engström. [1957] [17]p. incl. diagrs. (Bound with its AFOSR-TN-57-436; AD 136426) [AF 18(600)1045] Unclassified

Also published in Proc. First Internat'l. Symposium on X-ray Microscopy and Microradiography, Cavendish Lab., Cambridge (Gt. Brit.) (Aug. 16-21, 1956), New York, Academic Press, 1957, p. 240-248.

Due to lack of information concerning the intensity distribution of energy in the low wavelength end of a continuous x-ray spectrum it is desirable to use monochromatic sources for the absorption studies used to weigh cell and tissues. A treatment is given to the question of the optimum sample thickness, wavelength and exposure time which are necessary for obtaining maximum information. These conditions depend on the type of treatment, either visual or quantitative microphotometric evaluation, which is used in the analysis. Optimum conditions for each of the two methods is given.

POM.01:007

Pomona Coll. Dept. of Physics, Claremont, Calif.

MONOCHROMATIC SOURCES OF ULTRASOFT X-RADIATION FOR QUANTITATIVE MICRORADIOGRAPHIC ANALYSIS, by B. L. Henke. [1957] [26]p. incl. illus. diagrs. table. (Bound with its AFOSR-TN-57-436; AD 136426) [AF 18(600)1045] Unclassified

Also published in Proc. First Internat'l. Symposium on X-ray Microscopy and Microradiography, Cavendish Lab., Cambridge (Gt. Brit.) (Aug. 16-21, 1956), New York, Academic Press, 1957, p. 72-88.

A method is described for the isolation of the characteristic line radiation in the very soft x-ray region which can provide sources of relatively high intensity and monochromaticity which are satisfactory for research on and the development of quantitative microradiographic techniques. Monochromatization by filter alone, by a filter plus a plane mirror, and by a filter plus a cylindrical mirror are described. A description of the source and camera design is given.

POM.01:008

Pomona Coll. Dept. of Physics, Claremont, Calif.

SEMIEMPIRICAL DETERMINATION OF MASS ABSORPTION COEFFICIENTS FOR THE 5 TO 50 ANGSTROM X-RAY REGION, by B. L. Henke, R. White, and B. Lundberg. [1957] [8]p. incl. diagrs. tables. (Bound with its AFOSR-TN-57-436; AD 136426) [AF 18(600)1045] Unclassified

Also published in Jour. Appl. Phys., v. 28: 98-105, Jan. 1957.

POM.01:009-012; POM.02:001

A semilempirical method for the determination of mass absorption coefficients for the very soft x-ray region of 5 to 50A is described. A universal function for the absorption by K-shell electrons and another for absorption by L and extra-L shell electrons are given in table form to permit the calculation of mass absorption coefficients for elements of atomic number up to 38. Calculated and observed values from available absorption data are compared with those predicted by quantum theory. Tables are given for the mass absorption coefficients for nine useful wavelengths in the ultra-soft region, 8.34, 13.3, 17.6, 21.7, 23.7, 27.4, 31.6, 36.3 and 44A. (Contractor's abstract)

POM.01:009

Pomona Coll. [Dept. of Physics] Claremont, Calif.

MICORADIOGRAPHIC ANALYSIS OF MICRON SYSTEMS (Abstract), by B. L. Henke. [1957] [1]p. [AF 18-(600)1045] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 210, Apr. 25, 1957.

The "contact printing" of images of microscopic material which is laid upon ultra-fine grain photographic plates can yield micrograms which permit microscopic and microphotometric analysis of systems of micron dimensions. Sufficient absorption signal or contrast can be obtained for these systems when the contact microradiograms are made with the ultra-soft x-radiations in the 10 to 50A region. Standard absorption analysis techniques can be applied to the microradiograms for quantitative micromass and microchemical analysis provided that good mass absorption coefficient data for this radiation region are obtained, and provided that the proper design of the contact microradiographic camera, of the photographic emulsions, and of the microphotometric apparatus is employed. A first report on the work conducted at this laboratory on the theory and practice of contact microradiographic analysis for micron systems will be presented.

POM.01:010

Pomona Coll. Dept. of Physics, Claremont, Calif.

ULTRASOFT X-RAY ANALYSIS OF MICRON SYSTEMS, by B. L. Henke. [1957] [25]p. incl. illus. diagrs. tables. (Bound with its AFOSR-TN-57-436; AD 136426) [AF 18-(600)1045] Unclassified

Also published in Norelco Reporter, v. 4: 82-87, July-Aug. 1957

The advantages of using long wavelength (10 to 100A)

x-ray radiation for thin samples of materials have been outlined. An introduction is given to the diffraction, absorption and reflection methods of analysis available with long wavelength x-rays. A brief description is given of some of the sources, methods of producing monochromatic beams, and the detectors used in these long wavelength studies.

POM.01:011

Pomona Coll. [Dept. of Physics] Claremont, Calif.

TABLES FOR THE COMPUTATION OF INTENSITY DISTRIBUTION FUNCTIONS FOR ISOTROPIC NON-ABSORBING SPHERES, by J. C. Miller. [1957] [2]p. (Bound with its AFOSR-TN-57-436; AD 136426) [AF 18-(600)1045] Unclassified

The diffracted x-ray intensity distribution for isotropic non-absorbing spheres is given in terms of the refractive index of the substance, the angle into which the energy is diffracted and the x-ray wavelength used.

POM.01:012

Pomona Coll. Dept. of Physics, Claremont, Calif.

[PHYSICS OF SOFT X-RAYS] Interim final rept. Nov. 1958 [3]p. (AFOSR-TR-58-164) (AF 18(600)1045) AD 207831 Unclassified

This project has been concerned with the physics of ultrasoft x-radiations which lie in the wavelength region between conventional x-rays and the extreme ultraviolet. It has been an attempt to systematically investigate the important interactions of these radiations with matter, viz. (1) diffraction, (2) total reflection, (3) photoelectric absorption, (4) auger and photoelectron emissions. Because the cross sections for these interactions are large even for micromass thicknesses, a parallel investigation on the applications of ultrasoft x-ray interactions to micromass and microchemical analysis has been carried out. To date, these have included: (1) submicroscopic structure analysis by diffraction, (2) thin film analysis by total reflection, and (3) micromass and microchemical analysis by high resolution microradiography. Because relatively little work has been done previously in this field, an integral part of this program also has been the development of ultrasoft x-ray instrumentation.

POM.02:001

Pomona Coll. Dept. of Physics, Claremont, Calif.

HIGH RESOLUTION MICORADIOGRAPHY, by B. L. Henke. Sept. 1958, 64p. incl. illus. diagrs. tables. (Technical rept. no. 2) (AFOSR-TN-58-803) (AF 49-(638)394) AD 202236; PB 137178 Unclassified

POM.02:002-004; PRL 13:001

The requirement of ultrasoft x-radiation (10 to 100A) for high resolution microradiographic analysis is established. Optimum methods are described for obtaining structure, mass distribution and mass-chemical information for microscopic sample regions as small as a few square microns and for total mass as small as a few micro-micrograms. The details of the techniques and of the instrumentation which are used in high resolution microradiographic analysis are presented. (Contractor's abstract)

POM.02:002

Pomona Coll. [Dept. of Physics] Claremont, Calif.

HIGH-RESOLUTION MICRORADIOGRAPHIC ANALYSIS (Abstract), by B. [L.] Henke. [1958] [1]p. [AF 49(638)-394] Unclassified

Presented at meeting of the Electron Microscope Soc. Amer., Santa Monica, Calif., Aug. 7-9, 1958.

Published in Jour. Appl. Phys., v. 29: 1618, Nov. 1958.

A report is made of work in progress on the use of ultrasoft x-radiations of the 8 to 44A region for microradiographic analysis of micron systems. Special sources, monochromators, and camera geometries are described. High-resolution microradiographic technique, the resolution limit of available photographic materials, and the sources of error in mass and chemical analysis by microradiography are discussed.

POM.02:003

Pomona Coll. [Dept. of Physics] Claremont, Calif.

CALCULATION OF ULTRASOFT X-RAY DISPERSION COEFFICIENTS (Abstract), by J. C. Miller and B. L. Henke. [1958] [1]p. [AF 49(638)394] Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 413, Dec. 29, 1958.

The semiempirical method described in a previous paper (item no. POM.02:004) for the calculation of atomic form factors in ultrasoft x-ray dispersion theory leads to the extensive application of numerical techniques, particularly in integrations involving singularities within the range of integration. In this case use has been made of the usual Cauchy's principal value definition and of a modified form of Simpson's rule applicable to a rational function for the integrand. A further difficulty is encountered in attempting to perform the integration under limiting conditions on certain parameters of the integrand. In these calculations assistance was rendered by the personnel and facilities of the Western

Data Processing Center of UCLA. A program for the calculation of transmission efficiencies of ultrasoft x-rays at grazing incidence through thin films forms an additional part of the present study. This work uses the standard two surface optics as given, for example, by Wolter. The latter calculation was performed on the computing facilities of the Millikan Laboratory, Pomona College, Claremont.

POM.02:004

Pomona Coll. [Dept. of Physics] Claremont, Calif.

X-RAY DISPERSION IN THE 5 TO 50A WAVELENGTH REGION (Abstract), by B. L. Henke and J. C. Miller. [1958] [1]p. [AF 49(638)394] Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 413, Dec. 29, 1958.

The complex atomic scattering factors for the light elements C_6 to Ge_{32} and for the long wavelength x-ray region have been calculated from mass photoelectric absorption coefficients using an integral relationship given by the quantum mechanical theory of dispersion. The anomalous scattering due to electron "resonances" at the K and the L critical absorption edge wavelengths has been found to be more extensive than that predicted by the older dispersion theories. The reflection efficiency as a function of both angle of reflection and of wavelength has been calculated for a quartz and an aluminum mirror from the atomic scattering coefficients. The predicted reflection curves are found to be in good agreement with those obtained experimentally. Ultrasoft x-ray interactions as absorption, diffraction, grazing incidence reflection, and transmission are being investigated as bases for the analysis of microscopic systems for structure, mass, and chemical information.

Princeton U., N. J.

N60ri-10503, Project Squid see under Princeton U. James Forrestal Research Center, N. J. (Project Squid) item no. PRL11:212, 213.

PRL13:001

Princeton U. [Chemical Engineering Lab.] N. J.

KINETICS AND MECHANISM OF CATALYTIC REACTIONS, by M. Boudart. [1958] [14]p. (AFOSR-TN-58-203) (AF 49(638)32) AD 152235 Unclassified

Also published in Indus. Chim. Belge, v. 23: 383-396, Apr. 1958.

A comparison is made between certain catalytic reactions and their homogeneous counterparts. Thus,

PRL 12:005, 006; PRL 04:016, 017

ethylene hydrogenation and sulfur dioxide oxidation are chain reactions in the gas and the liquid phase, respectively. The role of the catalyst is to provide an easier initiation step that generates surface radicals. The identification of the rate determining step in any catalytic reaction is an important part of any mechanism study and this point is illustrated by the example of ammonia synthesis. Fortunately, it appears that surface heterogeneity can usually be ignored if all that is desired is a workable rate equation. (Contractor's abstract)

PRL 12:005

Princeton U. [Dept. of Aeronautical Engineering] N. J.

HIGH SPEED AERODYNAMICS AND JET PROPULSION. VOLUME VII. AERODYNAMIC COMPONENTS OF AIRCRAFT AT HIGH SPEEDS, ed. by A. F. Donovan and H. R. Lawrence. N. J., Princeton U. Press, 1957, 845p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Office of Ordnance Research under [Nonr-03201])

Unclassified

The primary concern of this volume is to present aerodynamic knowledge that is of direct interest to the designers of high speed aircraft. The items deal primarily with aircraft components, i.e. wings (in both steady and nonsteady motion), bodies, interference effects, propellers, diffusers, and nozzles. The volume begins with a comprehensive treatment of the steady state aerodynamic theory of wings by R. T. Jones and D. Cohen. The tables of flow functions in this section should be particularly useful to the practicing aerodynamicist. C. Brown next presents a section on the aerodynamics of bodies at high speed, which is noteworthy for including bodies of noncircular cross section—a type which is usually given too little attention. Interactions between wings, body, tail, and propeller are treated in a section by C. Ferrari, who was aided in translation by R. Cramer. This section is notable for bringing together much information which otherwise can only be found scattered widely through the literature. Propellers at high speeds, including supersonic propellers, are covered in a section by C. B. Smith. A section on diffusers and nozzles by J. C. Evvard completes the treatment of the external aerodynamics of high speed propulsion systems. The basis for the treatment of aeroelastic problems is presented in a section by I. E. Garrick on nonsteady wing characteristics. Finally, a section by C. W. Frick on the experimental aerodynamics of wings clearly brings out the accomplishments of aerodynamic theory and the limitations imposed by assumptions.

PRL 12:006

Princeton U. [Dept. of Aeronautical Engineering] N. J.

HIGH SPEED AERODYNAMICS AND JET PROPULSION.

VOLUME III. FUNDAMENTALS OF GAS DYNAMICS, ed. by H. W. Emmons. N. J., Princeton U. Press, 1958, 746p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Office of Ordnance Research under [Nonr-03201])

Unclassified

In this volume the fundamentals of gas dynamics are developed and then applied to the flow through nozzles and passages, to shock phenomena of various kinds, to condensation effects, to flames and detonations, and to the flow of rarefied gases.

PRL 04:016

Princeton U. Dept. of Aeronautical Engineering, N. J.

AN ANALYSIS OF THE INTERACTION OF SHOCK WAVES WITH UNSEPARATED TURBULENT BOUNDARY LAYERS, by A. G. Hammitt. Feb. 1957 [24]p. incl. illus. diagrs. refs. (Rept. no. 371) (AFOSR-TN-57-108) (AF 18(600)498) AD 120460

Unclassified

Analysis of the behavior of turbulent boundary layers through rapid pressure rises may be described by a modified shock wave theory based on average boundary layer parameters. This method may be applied to shock wave boundary layer interactions at pressure ratios insufficient to cause separation. The results show that the properties of a boundary layer behind a discontinuous pressure rise may be considerably different than the ones measured in mild pressure gradients.

PRL 04:017

Princeton U. Dept. of Aeronautical Engineering, N. J.

UNSTEADY LAMINAR BOUNDARY LAYER OVER A FLAT PLATE IN THE DOWNSTREAM REGION, by S.-I. Cheng and I. D. Chang. Mar. 1956 [24]p. incl. diagrs. refs. (Rept. no. 339) (AFOSR-TN-57-180) (AF 18(600)498) AD 126475

Unclassified

The unsteady motion of a flat plate in an incompressible viscous fluid is studied by using Rayleigh's method. Formulas for calculating velocity profiles and skin friction are presented together with many examples to show their application. These results are applied to the problem of a moving plate, and the relationship between the velocity of the plate and the force applied is discussed. The chief implication of such a study is due to the fact that in the unsteady motion of a plate, a dominating portion of the flow field belongs to the Rayleigh type and hence for common engineering applications, the present analysis affords a good approximation. In general, the approximation holds good from downstream up to the point lying at the middle point between the instantaneous and the original leading edge position. In computing the velocity profiles and skin friction, it was found that the analytical representations for the final results were

PRI.04:018 - PRI.04:021

generally very lengthy and did not usually give a numerical result. Therefore in the practical applications, general solutions presented in this paper may very often be more conveniently used by direct numerical integration. Some general properties of these solutions are also contained in the analysis and may serve as a general guide to the final results. (Contractor's abstract)

PRI.04:018

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE MIXING THEORY OF CROCCO AND LEES AND ITS APPLICATION TO THE INTERACTION OF SHOCK WAVE AND LAMINAR BOUNDARY LAYER. PART I. GENERALS AND FORMULATION, by S.-I. Cheng and K. N. C. Bray. May 1957, 1v. incl. diagrs. tables, refs. (Rept. no. 376) (AFOSR-TN-57-283) (AF 18(600)498) AD 132354 Unclassified

The mixing theory of Crocco and Lees is reviewed briefly, and three semiempirical functions are evaluated, in terms of which the theory treats the growth of a boundary layer. A description is given of how the theory may be applied to laminar and turbulent boundary layer shock wave interactions. Three simple approximate solutions of the equations are developed, and finally, an exact solution is found numerically for a laminar boundary layer at a Mach number of 2 and an initial Reynolds number of 10^5 . Five shock strengths, giving deflection angles between 2° and 4.2° , are considered. This set of sample calculations illustrates how the theory may be applied to determine the flow configuration of the interaction between shock wave and laminar boundary layer in general. The procedure is then applied to the following specific problem, the determination of the critical strength of the shock wave required to produce incipient separation of a laminar boundary layer on a flat plate for the Reynolds number and Mach number range in which the laminar boundary layer usually occurs. Simple correlations are obtained for (1) the pressure rise at the separation point in excess of the undisturbed free stream pressure as a function of Mach number and Reynolds number, and (2) the critical strength of the shock to produce incipient separation of a laminar boundary layer over a flat plate as a function of the Reynolds number and Mach number in question. According to the mixing theory, the separation pressure rise is independent of the flow configuration downstream of the separation point in agreement with the experimental data available. This part of the result is, therefore, not restricted to the case of incipient separation. (Contractor's abstract)

PRI.04:019

Princeton U. Dept. of Aeronautical Engineering, N. J.

AN ANALYSIS OF THE EFFECT OF SHOCK WAVES

ON TURBULENT BOUNDARY LAYERS, by A. G. Hammit, I. E. Vas, and S. Hight. July 1957 [39]p. incl. diagrs. refs. (Rept. no. 396) (AFOSR-TN-57-297) (AF 18(600)498) AD 132368 Unclassified

An analysis of boundary layer surveys in the region of the interaction of shock waves with turbulent boundary layers is presented. By this analysis, it is possible to determine the order of magnitude of the static pressure gradients across the boundary layer and changes of mass and momentum in the boundary layer. The results indicate that the static pressures across the boundary layer in the interaction region are far from constant and that shear forces have only a secondary effect on the total momentum in the boundary layer. (Contractor's abstract)

PRI.04:020

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE MIXING THEORY OF CROCCO AND LEES AND ITS APPLICATION TO THE INTERACTION OF SHOCK WAVE AND LAMINAR BOUNDARY LAYER. PART II. RESULTS AND DISCUSSION, by S.-I. Cheng and I. D. Chang. Nov. 1957 [47]p. incl. diagrs. tables. (Rept. no. 376, pt. 2) (AFOSR-TN-58-3) (AF 18(600)-498) AD 148042 Unclassified

The procedure developed in Part I (item no. PRI.04:018) is used to determine the critical strength of the incident shock wave required to produce incipient separation of a laminar boundary layer over a flat plate for the range of Re from $1-15 \times 10^5$ and for the range of free stream Mach number M from 1.5 to 4.0. Nineteen cases have been integrated. Simple correlations of the results for the separation pressure ratio and the critical pressure ratio are obtained as $C_p = \Delta p/p_0 = a(M-b) \cdot [Re_s \times 10^{-6}]^{-c}$. Comparison with two sets of available experimental data shows agreement in general but no quantitative conclusions can be affirmed without the guidance of more detailed and extensive experimental information. It is suggested that this form of correlation may be obtained for the non-flat plate problems according to the mixing theory. (Contractor's abstract)

PRI.04:021

Princeton U. Dept. of Aeronautical Engineering, N. J.

SOLUTION OF THE THREE-DIMENSIONAL LAMINAR BOUNDARY LAYER OVER THE SURFACE OF A ROTATING CONE, by C.-S. Wu. Apr. 1958 [11]p. incl. diagrs. table. (Rept. no. 415) (AFOSR-TN-58-301) (AF 18(600)498) AD 154211 Unclassified

Also published in Appl. Scient. Res., v. A 8: 140-146, 1959. (Title varies)

PRI.04:022 - PRI.04:025

The problem under study is the investigation of the motion of an incompressible viscous fluid induced by a spinning cone. Similar solutions were found from the steady state boundary layer equations. Part of the numerical results are similar to that in Karman-Cochran's solution for infinite disk. The pressure distribution across the boundary layer is obtained by simple integration.

value problems for steady boundary layer equations, where only one upstream condition is allowed. (Contractor's abstract)

PRI.04:024

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE MECHANISMS OF ATMOSPHERIC ABLATION, by S.-I. Cheng. Apr. 1958 [31]p. incl. diagrs. table, refs. (Rept. no. 427) (AFOSR-TN-58-649) (AF 18(600)-498) AD 162181; PB 144042 Unclassified

Also published in Proc. Ninth Internat'l. Astronaut. Congress, Amsterdam (Holland) (Aug. 25-30, 1958), Austria, Springer-Verlag, 1959, p. 252-264.

The problem of ablation of meteoric objects entering the atmosphere is considered. Existing theory of meteoric ablation due to Lindemann and Dobson from the continuum point of view and that due to Sparrow-Opik from the particle point of view requires some modification. The deceleration of the meteor and the presence of a molten layer over the meteoric body results in an unstable liquid-gas interface that leads to the direct loss of mass as liquid droplets flying away from the meteoric surface. The feasibility of this mechanism is analytically shown and demonstrated with typical examples. By incorporating the present mechanism, the irregularity of the meteoric luminosity when compared with the calculated results of Opik's theory may be qualitatively explained and the occasional "burst" or "flare" of some meteors may be visualized. Several other observations of the meteoric phenomena also tend to verify the plausibility of the proposed mechanism. (Contractor's abstract)

PRI.04:025

Princeton U. Dept. of Aeronautical Engineering, N. J.

AXISYMMETRIC STAGNANT FLOW OF A VISCOUS AND ELECTRICALLY CONDUCTING FLUID NEAR THE BLUNT NOSE OF A SPINNING BODY WITH PRESENCE OF MAGNETIC FIELD. PART II. CONSIDERATION OF REALISTIC CONDITIONS: COMPRESSIBLE VISCOUS LAYER AND SMALL MAGNETIC REYNOLDS NUMBER, by C.-S. Wu. Sept. 1958 [37]p. (Rept. no. 431) (AFOSR-TN-58-711) (AF 18(600)498) AD 207161 Unclassified

The second part of the present study of the axisymmetric stagnation point flow of a viscous and conducting fluid near a spinning body is presented. A more realistic physical model is adopted in the present case. The compressibility and variable physical properties are taken into consideration. In the viscous layer, boundary layer approximation is employed. Since

PRI.04:022

Princeton U. Dept. of Aeronautical Engineering, N. J.

AXISYMMETRIC STAGNANT FLOW OF A VISCOUS AND ELECTRICALLY CONDUCTING FLUID NEAR THE BLUNT NOSE OF A SPINNING BODY WITH PRESENCE OF MAGNETIC FIELD. PART I. EXACT SOLUTION OF INCOMPRESSIBLE AND CONSTANT-PROPERTIES MODEL, by C.-S. Wu and W. D. Hayes. Apr. 1958 [46]p. incl. diagrs. tables, refs. (Rept. no. 431) (AFOSR-TN-58-405) (AF 18(600)498) AD 158208 Unclassified

This is the first part of a series of studies of the stagnation point flow of a viscous and conducting fluid near the blunt nose of a moving and spinning body in the presence of magnetic field. The body under consideration is axisymmetric and the fluid is assumed to be incompressible and has constant properties. Exact similar solution is verified in existence. The final differential systems contain one principal system and two subordinate systems. Only general discussions are given in this report. The results of numerical computation will be presented sometime later. (Contractor's abstract)

PRI.04:023

Princeton U. Dept. of Aeronautical Engineering, N. J.

SHOCK INDUCED UNSTEADY LAMINAR COMPRESSIBLE BOUNDARY LAYERS ON A SEMI-INFINITE FLAT PLATE, by S. H. Lam and L. Crocco. Sept. 1958, 1v. incl. diagrs. refs. (Rept. no. 428) (AFOSR-TN-58-581) (AF 18(600)498) AD 162101; PB 146017 Unclassified

Also published in Jour. Aero/Space Sciences, v. 26: 54-56, Jan. 1959. (Title varies).

An investigation was conducted on the shock induced two-dimensional unsteady laminar compressible boundary layer on a semi-infinite flat plate. The shock is considered to have constant strength and advancing into a quiescent gas. The flat plate is at zero incidence and is at rest. The Prandtl boundary layer approximation is adopted. This class of unsteady laminar boundary layers has the peculiar feature that it possesses, at any instant, two streamwise boundary conditions; at any instant the boundary layer must have zero thickness at both the leading edge and at the shock. This is at variance with the conventional formulation of boundary-

PRI.04:026 - PRI.04:030

magnetic Reynolds number is postulated to be small, mathematical simplification of the induction equation is, therefore, obtained. (Contractor's abstract)

PRI.04:026

Princeton U. Dept. of Aeronautical Engineering, N. J.

INVESTIGATION OF THE INTERACTION OF A TURBULENT BOUNDARY LAYER WITH PRANDTL-MEYER EXPANSION FANS AT $M=1.88$, by K. R. A. Murthy and A. G. Hammit. Aug. 1958 [34]p. incl. illus. diags. (Rept. no. 434) (AFOSR-TN-58-839) (AF 18(600)498) AD 203081; PB 144580 Unclassified

The interaction of expansion fans with a 2-dimensional supersonic turbulent boundary layer at a free stream $M=1.88$ was investigated. The angle of expansion was varied from 5° to 30° . Schlieren photographs of the flow pattern were taken to obtain an over-all picture of this type of interaction. Static pressure and total head tube measurements were made to study the interaction in detail. The method of rotational characteristics was applied to the boundary layer velocity distribution as it expands about a convex corner to construct the flow field and to calculate the inviscid pressure distribution near the convex corner as a better approach to the problem than the classical Prandtl-Meyer flow. A turbulent boundary layer was found to affect the wall pressure distribution caused by a supersonic expansion around a convex corner for about 5 boundary layer thicknesses. The effect of the boundary layer can be predicted to a first approximation by considering the distorted profile ahead of the corner and considering the boundary layer flow inviscid through the expansion region. A region of high shear is created behind the corner which, in some respects, has the appearance of a new boundary layer originating from the corner. (ASTIA abstract)

PRI.04:027

Princeton U. Dept. of Aeronautical Engineering, N. J.

EXPERIMENTAL STUDIES AT MACH NUMBERS 12 TO 19 OF CONICAL AND BLUNTED BODIES AT ZERO ANGLE OF ATTACK, by S. M. Bogdonoff and I. E. Var. Sept. 1958 [56]p. incl. illus. diags. (Rept. no. 435) (AFOSR-TN-58-841) (AF 18(600)498) AD 203181; PB 143655 Unclassified

An experimental study on the conical and blunted bodies was carried out at Mach numbers between 12 and 19 using the Princeton University Helium Hypersonic Tunnel. Pressure distributions and Schlieren photographs were obtained for bodies with cone half angles varying from 10° to 45° . Comparison with the theoretical inviscid and Newtonian pressures corrected for normal shock losses were made. The pressures on a body without corners can be predicted quite well. A corner at the junction of the nose section and conical afterbody results in large

variations between the measured values and predicted ones. The pressures on the conical bodies were not affected by the nose shape for that part of the body downstream of a station located at $1\frac{1}{2}$ times the nose bluntness diameter. (Contractor's abstract)

PRI.04:028

Princeton U. Dept. of Aeronautical Engineering, N. J.

A CLASS OF EXACT SOLUTIONS OF THE MAGNETO-HYDRODYNAMIC NAVIER-STOKES EQUATIONS, by C.-S. Wu. Sept. 1958 [51]p. incl. diags. tables. (Rept. no. 436) (AFOSR-TN-58-845) (AF 18(600)498) AD 204134 Unclassified

A class of similarity solutions of the magnetohydrodynamic Navier-Stokes equations have been found in this paper so that the original differential system may reduce to two ordinary differential equations. The equation governing the velocity field appears to be of first order but with a non-linear interaction term of the magnetic field. On the other hand, the magnetic induction equation is of second order. Solutions similar to those obtained by Landau and Squire for non-magnetic case are found by using a perturbation expansion of small σ (σ is the ratio of kinematic viscosity and magnetic viscosity). Throughout the analysis, the fluid is assumed to be incompressible, viscous and electrically conducting. The physical properties are also postulated to be constant. (Contractor's abstract)

PRI.04:029

Princeton U. [Dept. of Aeronautical Engineering] N. J.

CROCCO'S VORTICITY LAW IN A NON-UNIFORM MATERIAL, by C.-S. Wu and W. D. Hayes. [1958] [2]p. (AF 18(600)498) Unclassified

Published in Quart. Appl. Math., v. 16: 81-82, Apr. 1958.

In the derivation of Crocco's vorticity law there is a basic restriction, that the material in the flow field be uniform, that the flow be isocompositional. The purpose of this note is to express the corresponding form of the vorticity law valid with non-uniform material, such as a gas mixture with non-zero concentration gradients or a material in which a chemical reaction is proceeding.

PRI.04:030

Princeton U. [Dept. of Aeronautical Engineering] N. J.

THE INTERACTION OF SHOCK WAVES AND TURBULENT BOUNDARY LAYERS, by A. G. Hammit. [1958] [12]p. incl. illus. diags. tables, refs. (AF 18(600)498) Unclassified

PRI.14:001 - PRI.14:003

Published in Jour. Aeronaut. Sciences, v. 25: 345-356, June 1958.

A theory of shock-wave boundary-layer interaction consistent with available experimental data can be formulated on the basis of no external mixing and no skin friction. For shock waves not strong enough to cause separation, the boundary-layer properties behind the interaction can be calculated. For strong interactions where large separated regions exist, the possibility of the different types of interactions which have been observed can be demonstrated by using the appropriate flow models and describing the boundary layer as a one-parameter family. For all configurations, the pressure ratio at which separation occurs can be correlated by a boundary-layer form factor. (Contractor's abstract)

PRI.14:002

Princeton U. Dept. of Aeronautical Engineering, N. J.

THE KINETICS AND MECHANISM OF ETHYLENE OXIDE DECOMPOSITION AT HIGH TEMPERATURES, by L. Crocco, I. Glassman, and I. E. Smith. Apr. 10, 1958 [19]p. incl. diagrs. refs. (Rept. no. 416) (AFOSR-TN-58-273) (AF 18(600)1527) AD 154174; PB 131932

Unclassified

Also published in Jour. Chem. Phys., v. 31: 506-510, Aug. 1959.

A flow reactor has been built to study combustion processes in rocket motors and for systems that have reaction times from 1 to 100 msec. This reactor has been evaluated by means of this study of the kinetics of the decomposition of ethylene oxide in the temperature range from 900°K up to its decomposition temperature. The experiments were conducted with N as the inert carrier gas, but Ar and CO₂ were also used. A wide range of flow velocities were used in order to spread the reaction zone over a suitable distance. The overall reaction rate constant was evaluated assuming first order kinetics and a free radical mechanism for the decomposition process. The data were also evaluated with 0.5, 3/2, and second-order determinations to establish the sensitivity of the procedure. The calculated activation energy of the reaction was 42 ± 2 kcal/mol. Experiments conducted with various inerts as the carrier gas in the flow reactor indicated that the overall decomposition characteristics of the ethylene oxide are independent of the flow rate, concentration, and the variety of the inert used.

PRI.14:001

Princeton U. Dept. of Aeronautical Engineering, N. J.

A FLOW REACTOR FOR HIGH TEMPERATURE REACTION KINETICS, by L. Crocco, I. Glassman, and I. E. Smith. June 7, 1957 [7]p. incl. diagrs. (Rept. no. 398) (AFOSR-TN-57-373) (AF 18(600)1527) AD 132445

Unclassified

Also published in Jet Propulsion, v. 27: 1266-1267, Dec. 1957.

A flow reactor is described which was designed for the study of reaction kinetics of propellants at high temperatures. The reactor consists of a stainless steel tubular duct in which a high-temperature stream of inert gas flows. A cold stream of monopropellant or fuel-oxidizer mixture is mixed rapidly with the inert gas. The reaction begins downstream of the injection point and continues until all components are consumed. By introducing only a small quantity of the reactants compared with the mass flow of carrier, the temperature decrease resulting from the mixing of the 2 streams and the temperature increase due to the exothermic reaction are small. The rate of decomposition of ethylene oxide with either N or He as the carrier gas was determined. The tubular duct was heated electrically to maintain a constant temperature. The inert gas was heated to the same temperature. The test fuel injection section of the duct consisted of a sharply convergent section followed by a parallel throat 0.75 in. in diameter and about 1.3 in. long. Four small-bore injection tubes branching from a common manifold carried the fuel. They were arranged so that the streams issuing from them impinged on one another to create a region of high turbulence. The gas mixture was brought back to the duct by a 15° diffuser. The course of the reaction was followed by an axially transversing probe with a Pt-Pt/Rh thermocouple. The temperature record covered the range from 1020° to 1100°K. The mean velocity of the gas stream was 1520 cm/sec or 66 msec/meter of duct. The activation energy of the ethylene oxide reaction was 42 to 44 kcal/mol.

PRI.14:003

Princeton U. Dept. of Aeronautical Engineering, N. J.

PRELIMINARY STUDY OF THE LIGHT SCATTERING FOR DETERMINATION OF SIZE DISTRIBUTIONS IN BURNING SPRAYS, by R. A. Dobbins. July 15, 1958, 54p. incl. illus. diagrs. table, refs. (Rept. no. 430) (AFOSR-TN-58-822) (AF 18(600)1527) AD 202906; PB 138169

Unclassified

A research program was undertaken to study the details of the combustion processes which occur within the liquid propellant rocket motor. The aim of the program is to gain information on the relationship of the physical and chemical properties of the propellant combination to (a) the problem of scaling rocket motor designs, and (b) the problem of instability of the powerplant. The experimental method which will be used to implement this program consists of injecting a monopropellant fuel into the hot products of combustion formed by the fuel itself in a slave rocket motor. The study will be expanded to include the bipropellant case of fuel and oxidizer after some experience is gained with the more simple monopropellant case. The

PRI.14:004; PRI.15:001;
PRI.16:001, 002

instrumentation of the test section of the apparatus offers problems which warrant study in themselves. The determination of the droplet size distributions of a burning spray is one of the first factors meriting attention. Accordingly, a study was made of methods which might be applicable to follow the variation of particle size distributions in sprays undergoing evaporation in the presence of combustion. (Contractor's abstract)

PRI.14:004

Princeton U. Dept. of Aeronautical Engineering, N. J.

A STUDY OF THE KINETICS OF THE HYDROGEN-OXYGEN REACTION IN A NEW FLOW REACTOR, by R. J. Swigart. Aug. 15, 1958 [79]p. incl. illus. diagrs. table, refs. (Rept. no. 432) (AFOSR-TN-58-823) (AF 18(600)1527) AD 202907 Unclassified

A study of the kinetics of the hydrogen-oxygen reaction in the presence of large concentrations of nitrogen was made in a new type flow reactor under conditions which yielded data applicable to combustion processes in a rocket motor or ramjet combustor. The investigation was carried out over a temperature range from 900 to 1000°K. Initial hydrogen molar concentrations varied from 0.00826 to 0.0166 and initial oxygen molar concentrations varied from 0.0075 to 0.1975. A global reaction

$$\text{rate equation, } -\frac{dC_{H_2}}{dt} = k \frac{C_{H_2}}{(C_{O_2})^2}$$

[where C = concentration in mol/l and k = specific reaction rate constant], was found to correlate the data over the temperature, velocity, and concentration ranges studied. The specific reaction rate constant increased and the activation energy and ignition lag times decreased as duct diameter decreased. Thus, a strong catalytic reaction on the reactor walls was indicated. Evidence of a chain breaking wall reaction was observed. Activation energies of 34.2 kcal/mol, 33.4 kcal/mol and 25.2 kcal/mol were obtained for the 2 in., 1-1/2 in., and 1 in. duct respectively when air was used as the oxygen source. The activation energy of the reaction in the 2 in. duct decreased when part of the excess oxygen was replaced by nitrogen. (Contractor's abstract)

PRI.15:001

Princeton U. [Dept. of Aeronautical Engineering] N. J.

THE SHOCK TUBE AS A TOOL FOR SOLID PROPELLANT IGNITION RESEARCH, by M. Summerfield and R. F. McAlevy III. [1958] [4]p. incl. illus. diagrs. (AFOSR-TN-58-957) [AF 49(638)411] AD 162276 Unclassified

Also published in Jet Propulsion, v. 28: 478-481, July 1958.

The fundamental problem of the solid propellant ignition process is to clarify the mechanism by which the solid surface begins to burn. The relative roles in ignition initiation of heat transfer, chemical reaction at the surface and radiation absorption are still unknown. By means of a shock tube it is possible to ignite a solid propellant under controlled conditions to study the purely thermal process. This paper describes the design and operation of a shock tube being used for this purpose and presents some preliminary results. (Contractor's abstract)

PRI.16:001

Princeton U. Dept. of Aeronautical Engineering, N. J.

SIMPLE VORTICITY LAWS IN MAGNETOHYDRODYNAMICS, by C.-S. Wu. Nov. 1958, 17p. (Rept. no. 445) (AFOSR-TN-58-1044) (AF 49(638)465) AD 231173; PB 157730 Unclassified

Some simple vorticity laws in magnetohydrodynamics were derived. The discussions include the generalized Crocco's vorticity law (ZAMM, v. 17: 1-7, 1937) and Lighthill's vorticity expression (Jour. Fluid Mech., v. 2: 1-32, 1957) behind 3-dimensional shock wave. Finally, a generalization of Hayes dynamic derivation of vorticity jump across a gas dynamic discontinuity is obtained. (Contractor's abstract)

PRI.16:002

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE FLOW OF GASES UNDER NEARLY FREE MOLECULAR CONDITIONS, by D. R. Willis. Dec. 1958, 1v. incl. diagrs. tables, refs. (Rept. no. 442) (AFOSR-TN-58-1093) (AF 49(638)465) AD 207594; PB 149677 Unclassified

Boltzmann's equation is transformed into an integral equation, and an iterative method of solving for the distribution function is proposed. This method is shown to give the correct solution for the problem of linearized Couette flow, in contrast to several other proposed methods which are also examined. If the iteration commences with the free molecular distribution function, it appears that one iteration is sufficient to give the distribution function for nearly free molecular conditions. The method of first collisions is shown to be an approximate method of calculating this iterate. It is valid when the free stream Mach number is high and the body temperature is comparable to the free stream stagnation temperature. The method is applied to various geometries and results presented for the corrections to the free molecular macroscopic quantities at the body. There is found to be a marked effect of both body temperature and free stream Mach number. (Contractor's abstract)

PRI.16:003, 004; PRI.17:001-003

PRI.16:003

Princeton U. Dept. of Aeronautical Engineering, N. J.

HYPERSONIC VISCOUS FLOW PAST A BLUNT BODY WITH AN APPLIED MAGNETIC FIELD. PART I, by C.-S. Wu. Nov. 1958 [27]p. (Rept. no. 443) (AFOSR-TN-58-1125) (AF 49(638)465) AD 231174

Unclassified

This is the first portion of the present study on the hypersonic viscous effect flow past blunt-nosed bodies with hydromagnetic interaction. Local similarity solutions of flow field and temperature distribution have been found near the stagnation point region. The discussions may be grouped into two parts: the two-dimensional problem (circular cylinder) and the axisymmetrical problem (sphere). (Contractor's abstract)

by rational analytical expressions. These expressions reproduce the usual qualitative representation of this quantity much more closely than a limited power series and require only slightly more computational labor. (ASTIA abstract)

PRI.17:002

Princeton U. Dept. of Chemistry, N. J.

TRANSITION PROBABILITIES FOR THE MORSE OSCILLATOR WITH A CUBIC DIPOLE MOMENT, by D. Garvin. Feb. 17, 1958, 7p. (Technical note no. 2) (AFOSR-TN-58-146) (AF 18(603)134) AD 152173; PB 135074

Unclassified

A series of formulae are recorded for transition probability matrix elements for the non-rotating Morse oscillator suitable for use with linear, quadratic and cubic dipole moment expressions. These represent a re-formulation of the results obtained by Heaps and Herzberg for the case of the quadratic dipole moment expression, and an extension to the cubic integral. These formulae were derived using the factorization technique developed by Infeld and Hull and used by them to obtain the linear integral. A direct extension of the procedures explained by them yields the quadratic and cubic integrals. The expression for the quadratic integral yields the same specific formulae for particular transitions as those obtainable from the work of Heaps and Herzberg. The cubic integral has been checked, for several specific cases, against the results of Herman and Rubin. The principal advantage of the expressions is that the computational labor involved in the evaluation of transition moments for the higher 'overtone' bands is markedly reduced from that required when the other sets are used. In addition, certain approximations permit rapid computation with little loss in accuracy. (Contractor's abstract)

PRI.16:004

Princeton U. Dept. of Aeronautical Engineering, N. J.

A NOTE ON THE PRESSURE DISTURBANCE AT GROUND LEVEL CAUSED BY HIGH-FLYING SUPERSONIC AIRCRAFT, by N. C. Freeman and S. E. Lam. Dec. 1958 [11]p. incl. diagr. (Rept. no. 444) (AFOSR-TN-58-1127) (AF 49(638)465) AD 207781

Unclassified

The pressure disturbance or bang produced on the ground by a high-flying supersonic aircraft is studied. The main interest is (1) to assess the effect of the non-uniformity of the atmosphere in attenuating the waves from the aircraft, and (2) to relate this to some gross parameters of the aircraft. The linear supersonic flow theory is used to compute the pressure disturbance at a large distance from the aircraft and the attenuation of this disturbance through a Rand standard atmosphere is computed by a simple application of Whitham's theory. Formulas for either a lift-controlled or shape-controlled bang are given as a function of the gross parameters of the aircraft such as flight Mach number, altitude, size, slenderness ratio, lift coefficient, and certain design factors which depend on rather detailed knowledge of the aircraft. (Contractor's abstract)

PRI.17:003

Princeton U. Dept. of Chemistry, N. J.

A SPECTROSCOPIC INVESTIGATION OF THE NITRIC OXIDE-OZONE REACTION, by J. C. Greaves and D. Garvin. July 17, 1958 [22]p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-58-744) (AF 18-603)134) AD 201510

Unclassified

Also published in part in Jour. Chem. Phys., v. 30: 348-349, Jan. 1959. (Title varies)

The spectrum of the emission accompanying the reaction of nitric oxide with ozonized oxygen containing 4% ozone has been recorded photographically between 5900 and 10850 Å, but has not yet been successfully analyzed. A complex system of unresolved bands is observed overlying an apparent continuum. The emitter responsible for the bands is believed to be an excited nitrogen

PRI.17:001

Princeton U. Dept. of Chemistry, N. J.

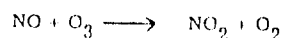
TRANSITION PROBABILITIES FOR THE ROTATING MORSE OSCILLATOR WITH AN EXPONENTIAL DIPOLE MOMENT, by D. Garvin. Feb. 5, 1958, 5p. (AFOSR-TN-58-95) (AF 18(603)134) AD 148144

Unclassified

Transition matrix expressions are given for the Morse oscillator on the assumption that the dipole moment, as a function of internuclear distance, may be described

PRI.17:004; PRI.06:006, 007

dioxide molecule formed in the reaction:



From the position of the short wavelength limit of the spectrum, it is apparent that some of the nitrogen dioxide molecules which are formed carry away nearly 100% of the energy of reaction. There is thus a large non-equilibrium distribution of energy in the reaction zone. (Contractor's abstract)

PRI.17:004

Princeton U. Dept. of Chemistry, N. J.

CHEMICALLY INDUCED VIBRATIONAL EXCITATION: A STUDY OF HYDROXYL RADICALS FORMED IN THE $\text{H} + \text{O}_3$ ATOMIC FLAME, by D. Garvin. Nov. 20, 1958,

1v, incl. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-58-1076) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)134 and National Bureau of Standards under CSO-680-56-30) AD 207455 Unclassified

Presented at meeting of the Phys. and Inorg. Chem. Div. of the Amer. Chem. Soc., Miami, Fla., Apr. 7-12, 1957.

Abstract published in 131st meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 15-R.

Also published in Jour. Amer. Chem. Soc., v. 81: 3173-3179, July 5, 1959.

The vibrational-rotational spectrum of the hydroxyl radical in its electronic ground state was determined in the visible and near infra-red region. Line systems in twenty-seven vibrational bands have been identified. Intensities of lines in eighteen bands are reported. No evidence of a Boltzmann distribution of rotational energies among these chemically produced radicals was found. The vibrational band intensities show an interrelationship that is not consistent with prediction based on the Morse Oscillator transition moment expressions. Further developments are needed in the theoretical models used for the interpretation of high "overtone" vibrational transitions. (Contractor's abstract)

PRI.06:006

Princeton U. [Dept. of Mathematics] N. J.

GENERALIZED SECOND ORDER DIFFERENTIAL OPERATORS AND THEIR LATERAL CONDITIONS, by W. Feller. [1957] [10]p. [AF 18(600)1379] Unclassified

Published in Illinois Jour. Math., v. 1: 459-504, Dec. 1957.

Let m be a (finite or infinite) regular positive measure

on a real interval I , vanishing on no subinterval, and let x be an everywhere positive continuous function.

The author studies the operator $A_\phi f = \phi^{-1} D_m \phi^2 D_x \phi^{-1} f$, continuing the work on second-order operators that he originally undertook in connection with diffusion processes (Ann. Math., v. 61: 90-105, 1955). The differentiation D_m is in the sense of Radon-Nikodym. The

operator A_ϕ is considered to be densely defined either on the space $L^2(m, I)$ of m -square-integrable functions, or else on the space $C(I)$ of continuous functions. In L^2 , when m is finite, Feller allows the end-points of I to carry positive weights, and in so doing defines conditions on A_ϕ from which the classical boundary conditions are

obtained as a degenerate limiting case. For particular absolutely continuous m and suitable function-multipliers and changes of variable, Feller's operator represents locally the most general classical ordinary linear second-order differential operator $D_x^2 + gD_x + h$. And for singular or discontinuous m it includes various non-classical cases previously treated singly by ad hoc methods. The theory of A_ϕ contains in a simple and elegant form the essentials of the traditional Sturm-Liouville and Weyl-Stone second-order theory.

PRI.06:007

Princeton U. [Dept. of Mathematics] N. J.

ON THE INTRINSIC FORM FOR SECOND ORDER DIFFERENTIAL OPERATORS, by W. Feller. [1958] [18]p. [AF 18(600)1379] Unclassified

Published in Illinois Jour. Math., v. 2: 1-18, Mar. 1958.

Let I be an open interval, and for each open subinterval J let A_J be a non-trivial linear operator with domain and range both contained in the space $C(J)$ of all continuous functions on J . Suppose also that if K is an open subinterval of J and if $g \in C(K)$ is the restriction of some f in the domain of A_J , then g belongs to the domain of

A_K and A_{Kg} is the restriction of $A_J f$ (but allow the domain of A_K to be perhaps larger than the restriction of the domain of A_J). This coherent collection of A_J defines

an operator A of local character. Example: An ordinary linear differential operator with continuous coefficients (and, say, leading coefficient nowhere zero). Among these classical operators the "pure" second-order ones,

$aD + bD^2$, have a characteristic minimum property: If f in the domain of A has a local minimum at x , then $(Af)(x) \geq 0$. In a definitive sequence of papers (Ann. Math., v. 61: 90-105, 1955; Comm. Pure. Appl. Math., v. 8: 203-216, 1955; Proc. Conf. on Differential Equations, Univ. of Maryland, 1956, p. 251-270; Illinois Jour. Math., v. 1: 459-504, 1957), Feller has invented and studied the

PRI.66:008; PRI.18:001-003

operator $D_m: D_m^2$ that naturally generalizes $aD^2 + bD$.

(The functions m and x are strictly monotone and intrinsically determined by the operator. Although m may have jumps, x is continuous and can thus serve to parametrize I .) In § 1-6 of the present paper, it is proven that any operator A of local character with the minimum property (has an extension that) equals some $D_m^2 + D_x$, provided only that A has (on each subinterval) a 2-dimensional nullspace. And in any event it is proven that A is $D_m^2 + D_x$ on the open set of "regular" points of I , but degenerates to a first-order operator at the "singular" points. In § 7-9, there is characterized by means of a weaker minimum property the operator $a^{-1}D_m^2 + D_x^{-1}$ (a any nowhere-zero element of the nullspace) that naturally generalizes $aD^2 + bD + c$. In § 10 three examples are provided that are of great help in understanding his fivefold classification of singular points. (Math. Rev. abstract)

RI.66:008

Princeton U. [Dept. of Mathematics] N. J.

A SPECIAL INTEGRAL TRANSFORMATION IN EUCLIDEAN SPACE, by S. Bochner and T. Kawata. [1958] [19]p. (AF 18(600)1379) Unclassified

Published in Ann. Math., v. 68: 150-158, July 1958.

The authors consider limits of the form

$$\lim_{T \rightarrow \infty} T^{-k} \int_{E_k} f(x_1, \dots, x_k) K(Tx_1, \dots, Tx_k) dx_1 \dots dx_k,$$

where E_k is the k -dimensional Euclidean space, and the kernel K is of the form

$$K(x_1, \dots, x_k) = K_0(x_1 + \dots + x_k) \prod_{j=1}^k K_j(x_j),$$

each K_j ($j = 0, 1, \dots, k$) being the Fourier transform of a bounded function in $L_1(-\infty, \infty)$. A typical result is that the above limit has the value $C_k (2\pi)^k f(0, 0, \dots, 0)$, where C_k is a constant depending on k , if f is continuous and in $L_1(E_k)$ and if the Fourier transform of f is in $L_1(E_k)$. The techniques of proof are fairly standard Fourier transformation techniques. The authors also consider generalizations of those results to kernels whose dependence on T is more complex. (Math. Rev. abstract)

RI.18:001

Princeton U. [Dept. of Mathematics] N. J.

COHOMOLOGY OPERATIONS AND OBSTRUCTIONS TO

EXTENDING CONTINUOUS FUNCTIONS, by N. E. Steenrod. Colloquium Lecture. Aug. 1957, 60p, incl. diagrs. (AFOSR-TN-57-548) (AF 18(600)1494) AD 136532 Unclassified

A discussion is presented of the extension problem and methods of finding solutions in special cases. The problem is described and by the homology theory, transformed into an algebraic problem. Among the examples of extension problem solutions are the Urysohn lemma, the use of the cohomology ring to arrive at a decision, and a retraction problem solved by the squaring operations. To explain the geometric aspects, the concept of homotopy is studied. Lifting problems are illustrated by the solution of the monodromy theorem. The classification theorems of Hopf and Hurewicz are pointed out as certain restricted situations where homology and cohomology are adequate to solve the homotopy classification problem. A method to prove these results is the obstruction theory introduced by Eilenberg. The methods of constructing cohomology operation are described with particular attention to the cup product which gives the ring structure. The squaring operations are defined with their properties and reduced power operations given. Another approach to cohomology operations is the use of the Eilenberg-MacLane complexes. A brief review of the research done on the semi-simplicial complexes is presented. The theorem of Dold and Thom brings together the 2 methods of obtaining cohomology operations. Spaces with 2 nonzero homotopy groups are discussed; the Postnikov systems take in spaces with 3 or more such groups.

PRI.18:002

Princeton U. Dept. of Mathematics, N. J.

ON THE HOMOLOGY OF $K(\pi, n)$, by J. C. Moore. [1957] [3]p. (AF 18(600)1494) Unclassified

Published in Proc. Nat'l. Acad. Sciences, v. 43: 409-411, May 1957.

A definition is given of some little constructions in the fashion of Cartan which enable the computation of the homology of the complexes $K(\pi, n)$ of Eilenberg and Mac Lane for finitely generated groups π . Using these constructions, some properties of the homology and cohomology of $K(\pi, n)$ can be derived. One of the main points about these constructions is that they are constructions over the ring of p -adic integers, \mathbb{Z}_p , and not, as usual in topology, constructions over the integers \mathbb{Z} , or the integers modulo n , \mathbb{Z}_n .

PRI.18:003

Princeton U. [Dept. of Mathematics] N. J.

ON c.s.s. CATEGORIES, by D. M. Kan. [1957] [13]p. incl. refs. (AF 18(600)1494) Unclassified

PRI.18:004 - PRI.18:007

Published in Bol. Soc. Mat. Mexicana, Series II, v. 2: 82-94, Oct. 1957.

The purpose of this paper is to obtain for c.s.s. categories (described in item no. PRI.18:004) analogues of (1) the homotopy extension and/or covering theorems, and (2) a theorem of J. H. C. Whitehead. The Whitehead theorem asserts that a map is a homotopy equivalence if and only if it induces isomorphisms of all homotopy groups. The main tool in these investigations is a functor from the c.s.s. category C^V to the usual category of c.s.s. complexes, which allows one to transfer most of the old definitions to the new context.

PRI.18:004

Princeton U. [Dept. of Mathematics] N. J.

ON THE HOMOTOPY RELATION FOR c.s.s. MAPS, by D. M. Kan. [1957] [7]p. (AF 18(600)1494) Unclassified

Published in Bol. Soc. Mat. Mexicana, Series II, v. 2: 75-81, Oct. 1957.

A c.s.s. complex is a collection of sets together with a collection of maps between the sets satisfying certain identities. A c.s.s. group is a collection of groups together with a collection of homomorphisms between the groups satisfying certain identities. Let C be any category and V the category consisting of the simplexes of the semisimplicial theory and the c.s.s. maps between them; then C^V denotes the category whose objects are contravariant functions $K:V \rightarrow C$ and that for two objects $K, L \in C^V$ a map $f:K \rightarrow L$ is a natural transformation. The function category, C^V , is called the c.s.s. category over C . If C allows a notation of sum (generalizing the idea of union), then the C^V notion of homotopy can be defined. The following sufficient condition is established: let C and D be categories with sums and let $\Theta:C^V \rightarrow D^V$ be a c.s.s. functor. Then Θ maps the homotopic maps over C into maps homotopic over D .

PRI.18:005

Princeton U. Dept. of Mathematics, N. J.

COHOMOLOGY OPERATIONS DERIVED FROM CYCLIC GROUPS, by N. E. Steenrod and E. Thomas. [1957] 24 p. (AF 18(600)1494) Unclassified

Published in Commentarii Mathematici Helvetici, v. 32: 129-152, 1957.

An improved result is presented for the generation of the cohomology operations called the reduced powers which are associated with some permutation group. The

generation set required in the present analysis consists of the Steenrod cyclic reduced powers and the Pontrjagin pth powers as compared with a larger set of 5 operations previously employed. (See item no. PRI.18:006).

PRI.18:006

Princeton U. Dept. of Mathematics, N. J.

COHOMOLOGY OPERATIONS DERIVED FROM THE SYMMETRIC GROUP, by N. E. Steenrod. [1957] [24]p. incl. diagrs. refs. (AF 18(600)1494) Unclassified

Published in Commentarii Mathematici Helvetici, v. 31: 195-218, 1957.

A full account is given of a new method by Steenrod of defining the reduced pth power cohomology operators and illustrating the relations in the basic properties of these operators. If G is any permutation group, then each homology class of G determines a cohomology operation. There are relations of dependence between various cohomology operations so obtained, and in the present paper two specific relations are discussed. If G is of degree n , then a homology class of G gives the same operation as does its image in the full symmetric group of degree n . It is also shown that the totality of cohomology operations based on the full symmetric group of degree n is generated by a subset consisting of those operations based on cyclic permutation groups of prime orders and degrees.

PRI.18:007

Princeton U. [Dept. of Mathematics] N. J.

COHOMOLOGY OPERATIONS, by N. E. Steenrod. [1956] [21]p. incl. refs. (AF 18(600)1494) Unclassified

Published in Internat'l. Symposium on Algebraic Topology, Mexico City (Aug. 1956), Mexico City, National U. of Mexico, 1958, p. 165-165.

An exposition is given of some of the basic properties of primary cohomology operations. It is based on the work of Steenrod, Thomas, Eilenberg and MacLane, Serre, and Cartan. Proof is also given of the following reduction theorem for cohomology operations of several variables. Let C denote the family of cyclic groups each of whose orders is either infinite or a power of some prime. Then every cohomology operation whose coefficient groups are finitely generated can be expressed as a composition of the following ones: addition, coefficient homomorphisms, cup products with coefficient groups in C , and cohomology operations of one variable with coefficient groups in C . Also there is a discussion of the problem of finding generators and relations for the cohomology operations of one variable with coefficient groups in C . (Math. Rev. abstract)

PRL18:008 - PRL18:011

PRL18:008

Princeton U. [Dept. of Mathematics] N. J.

SEMI-SIMPLICIAL COMPLEXES AND POSTNIKOV SYSTEMS, by J. C. Moore. [1958] [16]p. incl. diagrs. refs. (AF 18(600)1494) Unclassified

Published in Internat'l. Symposium. on Algebraic Topology, Mexico City (Aug. 1956), Mexico City, National U. of Mexico, 1958, p. 232-247.

An outline is presented of the theory of c.s.s. complexes, groups and fiber spaces, including a description of a Postnikov system as a sequence of twisted Cartesian products. Much of this material appears in Seminaire H. Cartan 1954/55 [Ecole Normale Supérieure, Paris, 1955]. (Math. Rev. abstract)

PRL18:009

Princeton U. [Dept. of Mathematics] N. J.

A COMBINATORIAL DEFINITION OF HOMOTOPY GROUPS, by D. M. Kan. [1958] [31]p. incl. refs. (AF 18(600)1494) Unclassified

Published in Ann. Math., v. 67: 282-312, Mar. 1958.

A definition of the homotopy groups of a simplicial complex (or more general: c.s.s. complex) using only the simplicial structure is given. It involves free groups where the corresponding definition of the homology group involve free abelian groups. The results are stated in terms of the c.s.s. complexes of (S. Eilenberg and J. A. Zilber). Semi-simplicial complexes and singular homology, Ann. Math., v. 51: 499-513, 1950). In Chapter I, several definitions and results on c.s.s. complexes and homotopy groups are reviewed. Chapter II contains the new definition of the homotopy groups. In Chapter III, it is shown in what precise sense the homology groups are "abelianized homotopy groups". Chapter IV, contains miscellaneous results on the construction G. It should be noted that in several definitions either the first or the last face or degeneracy operator plays a special role and that another definition could be obtained by using the other extremal operator. Both definitions, however, are essentially equivalent and it is mainly a matter of convenience which one is chosen.

PRL18:010

Princeton U. [Dept. of Mathematics] N. J.

ON HOMOTOPY THEORY AND c.s.s. GROUPS, by D. M. Kan. [1958] [16]p. (AF 18(600)1494) Unclassified

Published in Ann. Math., v. 68: 38-53, July 1958.

If A and B are topological groups, two homomorphisms $f_0, f_1: A \rightarrow B$ are called loop homotopic if there is a homotopy f_t between them such that each $f_t, 0 \leq t \leq 1$, is

a homomorphism. Homotopy need not imply loop homotopy. For c.s.s. groups and homomorphisms, the analogous definition requires existence of a c.s.s. homotopy $f_t: I \times A \rightarrow B$ such that $f(\alpha, \sigma \cdot \tau) = f(\alpha, \sigma) \cdot f(\alpha, \tau)$

for $\alpha \in I$ and $\sigma, \tau \in A$ (I is the c.s.s. complex of a 1-simplex); loop homotopy need not be an equivalence relation on c.s.s. homomorphisms, although of course it is in the topological case. A c.s.s. group A is called free (with distinguished basis) if (a) for every n, A_n is freely generated, and (b) for every generator $\sigma \in A_n$ and degeneracy operator η^1 on σ , $\sigma \eta^1$ is a generator of A_{n+1} .

For c.s.s. groups, free groups play a role similar to that played for c.s.s. complexes by Kan complexes (=complexes with extension condition); for example, if A is free, loop homotopy is an equivalence relation for c.s.s. homomorphisms $A \rightarrow B$. On the category of reduced complexes (K is reduced if it has only one 0-simplex) the author has defined a functor G to the category of free c.s.s. groups; conversely, on the category of c.s.s. groups is defined a functor \bar{W} (essentially the Eilenberg-MacLane construction) to the category of reduced Kan complexes. Restricting G to reduced Kan complexes and \bar{W} to free c.s.s. groups, the author shows that they induce an equivalence between homotopy theory (relative to the base point) in the one category and loop homotopy theory in the other. An example is given of two free c.s.s. groups of the same homotopy type but not the same loop homotopy type. (Math. Rev. abstract)

PRL18:011

Princeton U. [Dept. of Mathematics] N. J.

AN AXIOMATIZATION OF THE HOMOTOPY GROUPS, by D. M. Kan. [1958] [19]p. (AF 18(600)1494) Unclassified

Published in Illinois Jour. Math., v. 2: 548-566, Dec. 1958.

In the present paper an axiomatic characterization of homotopy groups on c.s.s. (complete semi-simplicial) complexes is given which is essentially different from the ones given by Serr, Milnor, Kuranishi, Hu, and others. A theory of homotopy groups on a subcategory S of the category of all c.s.s. complexes with base point is a collection of functors $\pi_n, n \geq 0$, from S to the category of groups, together with a natural boundary homomorphism for each fiber space $F \rightarrow E \rightarrow B$. The axioms are: (1) weak homotopy equivalences induces isomorphisms on homotopy groups; (2) exactness of the homotopy group sequence of a fiber space; (3) π_1 of a wedge product of two complexes is the free product of π_1 of each of the

PRI.18:012, 013; PRI.19:001

complexes; (4) $\pi_n(K) \neq 1$ for some K and n . Uniqueness is proved on the category of c.s.s. complexes weakly homotopy equivalent to countable c.s.s. complexes. Uniqueness is also proved for the category of all c.s.s. complexes when axiom (3) is strengthened to include infinite wedge products and the theory is extended to include π_0 . Finally it is shown that axioms (1) and (2) imply that $\pi_1(K(Z, 1))$ is torsion-free and abelian and hence that an arbitrary coefficient group cannot be introduced into the theory. A somewhat unfortunate feature of this axiomatization is that it requires for its statement, namely axiom (1), the definition of the usual homotopy groups on a c.s.s. complex. One wonders if axiom (1) could not be replaced by a homotopy axiom. (Math. Rev. abstract)

PRI.18:012

Princeton U. [Dept. of Mathematics] N. J.

MINIMAL FREE c.s.s. GROUPS, by D. M. Kan. [1958] [11]p. incl. diagrs. [AF 18(600)1494] Unclassified

Published in Illinois Jour. Math., v. 2: 537-547, Dec. 1958.

A subset S of a free c.s.s. group F (Kan, Ann. Math., v. 68: 38-53, 1958) is said to be a basis of F if it is closed under degeneracy and freely generates F . F is called a free product of subgroups G_1 and G_2 if there are free bases S_1 of G_1 such that $S_1 \cap S_2 = \emptyset$ and $S_1 \cup S_2$ is a basis of F . F is minimal if it has no contractible free factors (except the trivial one). The main theorems of this paper are that any free c.s.s. group F with trivial F_0 and finitely generated homotopy groups is the free product of a contractible subgroup and a minimal subgroup M . M and F are homotopy equivalent and M is determined up to isomorphism by the homotopy type of F (homotopy means homotopy in the category of c.s.s. groups). (Math. Rev. abstract)

PRI.18:013

Princeton U. [Dept. of Mathematics] N. J.

ON MONOIDS AND THEIR DUAL, by D. M. Kan. [1958] [10]p. [AF 18(600)1494] Unclassified

Published in Bol. Soc. Mat. Mexicana, v. 3: 52-61, 1958.

Let C be a category with products. A monoid structure on an object $A \in C$ is defined to be a map m of $A \times A$ into A satisfying appropriate axioms. A co-monoid structure is defined by reversing all the arrows in the above. It is shown that in the category of groups, a group is free if and only if it admits a co-monoid structure and a group

is abelian if and only if it admits a monoid structure. A simplified proof is given for the lemma in [Illinois Jour. Math., v. 2: 548-566, 1958] above which states, roughly, that a functor from countable groups to groups which preserves short exact sequences and finite free products is either trivial or equivalent to the inclusion functor. Finally, it is shown that the F construction of Milnor [Mimeographed notes, Princeton U., 1956] is an isomorphism of the category of c.s.s. complexes onto the category of c.s.s. groups with co-monoid structure. (Math. Rev. abstract)

PRI.19:001

Princeton U. [Dept. of Mathematics] N. J.

GENERALIZED SECOND ORDER OPERATORS AND THEIR LATERAL CONDITIONS, by W. Feller. [1957] [46]p. (AFOSR-TN-57-141) (AF 18(603)24) AD 120500 Unclassified

Also published in Illinois Jour. Math., v. 1: 459-504, Dec. 1957.

Let m be a (finite or infinite) regular positive measure on a real interval I , vanishing on no subinterval, and let x be an everywhere positive continuous function. The operator $A f = \varphi^{-1} D_m^2 \varphi^2 D_m^{-1} f$ is studied. Taking the differentiation D_m in the sense of Radon-Nikodym, the operator A is considered to be densely defined either on the space $L^2(m, I)$ of m -square-integrable functions or else on the space $C(I)$ of continuous functions. In L^2 , when m is finite, the endpoints of I carry positive weights and define conditions on A_0 from which the classical boundary conditions are obtained as a degenerate limiting case. For particular absolutely continuous m and suitable function-multipliers and changes of variable, the operator represents locally the most general classical ordinary linear second-order differential operator $D_x^2 + gD_x + h$. For singular or discontinuous m it includes various non-classical cases previously treated. The endpoints of I are "active," "semi-active," or "natural" according to the behavior there of functions in the null space of A_0 . The main shortcoming of A_0 is that it cannot represent all second-order classical operators globally, but only the "pure" operators $D_x^2 + gD_x$. It is shown that the theory of A_0 can be reduced to that of $A_1 = D_m D_x$. (Math. Rev. abstract, modified)

PRL 19:002-004; PRL 08:010

PRL19:002

Princeton U. [Dept. of Mathematics] N. J.

ON THE INTRINSIC FORM FOR SECOND ORDER DIFFERENTIAL OPERATORS, by W. Feller. [1957] [18]p. (AFOSR-TN-57-142) [AF 18(803)24] AD 128431
U: classified

Also published in Illinois Jour. Math., v. 2: 1-18, Mar. 1958.

Let I be an open interval, and for each open subinterval J let A_J be a non-trivial linear operator with domain and range both contained in the space $C(J)$ of all continuous functions on J . Suppose also that if K is an open subinterval of J and if $g \in C(K)$ is the restriction of some f in the domain of A_J , then g belongs to the domain of A_K and A_{K_g} is the restriction of A_{Jf} (but allow the domain of A_K to be perhaps larger than the restriction of the domain of A_J). This coherent collection of A_J defines an operator A of local character, which with the minimum property (has an extension that) equals some $D_m D_x$ provided only that A has (on each subinterval) a 2-dimensional null space. A is $D_m D_x$ on the open set of "regular" points of I , but degenerates to a first-order operator at the "singular" points. (Math. Rev. abstract, modified)

PRL19:003

[Princeton U. Dept. of Mathematics, N. J.]

THE BIRTH AND DEATH PROCESSES AS DIFFUSION PROCESSES, by W. Feller. [July 1957] 58p. refs. (AFOSR-TN-57-354) (AF 18(803)24) AD 132427;
AD 208488 Unclassified

Also published in Jour. Math. Pures. Appl., v. 38: 301-345, Oct.-Dec., 1959.

The theory of the birth and death process is explained with emphasis on analytical methods; probabilistic interpretations and applications are briefly discussed. In analytic terms, the theory reduces to the construction of Markovian matrices such that each column satisfies an infinite system of differential equations and each row satisfies the adjoint system. The problem is treated by elementary methods without the benefit of any known results. A pair of adjoint diffusion equations are used which are analogous to the matrix form of the differential equations, and methods developed for second order differential operators are applied. A metric is introduced in the space E of states $0, 1, 2, \dots$, and the distance is used as the natural scale; a canonical measure is also introduced in E . Examples are cited for some cases, and probabilistic interpretations are given.

PRL19:004

Princeton U. [Dept. of Mathematics] N. J.

THE NUMBERS OF ZEROS AND OF CHANGES OF SIGN IN A SYMMETRIC RANDOM WALK, by W. Feller. [1957] [7]p. (AFOSR-TN-57-356) (AF 18(803)24) AD 132429 Unclassified

Also published in L'Enseignement Math., Series II, v. 3: 226-235, July-Sept. 1957.

Let $S_n = X_1 + X_2 + \dots + X_n$ where the X_j 's are independent and assume the values ± 1 with probability $\frac{1}{2}$. The author derives for this symmetric random walk explicit formulas for the probability distribution of the number of changes of sign and other related quantities. The derivations are of a very elementary nature and the paper is self-contained. (Math. Rev. abstract, modified)

PRL08:010

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XIX. THE EFFECT OF INTERNAL FIELD UPON MOLECULAR RELAXATION TIMES IN LIQUIDS, by R. C. Millar and C. P. Smyth. [1957] [14]p. incl. diag. table. (AFOSR-TN-57-30) [AF 18(800)1331] AD 115065 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 3310-3313, July 5, 1957.

The effect of the internal field in a liquid upon the dielectric relaxation times of its molecules is examined by comparing the macroscopic relaxation times of a highly polar liquid with that of a liquid consisting of molecules of the same size and shape as those of the polar liquid, but with very small dipole moment. The comparison is made alternatively between the pure polar liquid and its dilute solutions in a nonpolar solvent. After correction for viscosity differences in most cases, the assumption is made that the macroscopic relaxation time of the pure liquid of low polarity or of the dilute solutions of the polar liquid is equal to the molecular relaxation time of the highly polar liquid. The molecular relaxation times thus obtained are compared graphically with those calculated by means of the various available equations. It becomes evident that the relation of the molecular relaxation time to the macroscopic relaxation time is dependent not only upon the dielectric constant of the liquid, but also, to some extent, upon the molecular shape. As a result, no equation thus far proposed for calculating the molecular relaxation time from the directly measured macroscopic relaxation time of a polar liquid is wholly adequate, but that proposed by Powles (Jour. Chem. Phys., v. 21: 633, 1953) and obtained by

PRL08:011 - PRL08:014

O'Dwyer and Sack (Australian Jour. Sci. Res., v. 5A: 647, 1952) as a first approximation is the most nearly adequate. (Contractor's abstract, modified)

PRL08:011

Princeton U. Frick Chemical Lab., N. J.

THE DIPOLE MOMENT AND DIELECTRIC RELAXATION TIME OF ACEPLEIADYLENE, by D. A. Pitt, A. J. Petro, and C. P. Smyth. May 27, 1957 [2]p. incl. tables, refs. (AFOSR-TN-57-234) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)1331 and Office of Naval Research under [Nonr-185809]) AD 128531 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 5633-5634, Nov. 5, 1957.

The dipole moment and dielectric relaxation time of acepleiadylene have been measured in dilute benzene solution at 30°. The values were found to be $\mu = 0.49 \times 10^{-18}$ esu-cm and $\tau = 20.7 \times 10^{-12}$ sec, respectively. The moment is 50% of the value predicted by quantum mechanical calculations. Possible reasons for the low moment are discussed. The relaxation time is comparable to other aromatic compounds of similar size.

PRL08:012

Princeton U. Frick Chemical Lab., N. J.

DIPOLE MOMENT AND STERIC STRAIN IN HEXA-ARYLDISILANES, by A. J. Petro and C. P. Smyth. [July 1, 1957] [3]p. incl. refs. (AFOSR-TN-57-330) (AF 18(600)1331) AD 132404 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 6147-6169, July 1, 1957.

The dipole moments of 1,1,2-triphenyl-1,2,2-tri-p-tolyldisilane, 1,1,1-triphenyl-2,2,2-tri-p-tolyldisilane and 1,1,1-tri-phenyl-2,2,2-trimethyldisilane have been determined in dilute benzene solution. The measured values 0.80 , 0.77 and 0.64×10^{-18} , respectively, have been used to calculate a value of 115° for the aryl-silicon-silicon bond angle. Failure to detect free radicals in solution indicates that the distortion does not lead to measurable dissociation of these compounds. On the basis of available data and the measured moments, the following approximate maximum group moment magnitudes and their directions have been assigned: phenyl⁻ - $^+Si = 0.84 \times 10^{-18}$ and tolyl⁻ - $^+Si = 0.25 \times 10^{-18}$. (Contractor's abstract)

PRL08:013

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUID. XX. DIELECTRIC RELAXATION TIMES AND MOLECULAR SHAPES OF SOME SUBSTITUTED BENZENES AND PYRIDINES, by A. J. Petro and C. P. Smyth. July 1, 1957 [6]p. incl. tables, refs. (AFOSR-TN-57-331) (AF 18(600)1331) AD 132405 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 6142-6147, Dec. 5, 1957.

Measurements of dielectric constant and loss at wave lengths of 1.25, 3.22 and 10.0 cm and 300 m have been carried out at 20, 40 and 60° on toluene, styrene, ethylbenzene, isopropylbenzene, o-xylene, m-xylene, p-chlorotoluene, o-picoline, 2- and 4-vinylpyridine, and 2- and 4-ethylpyridine in the pure liquid state and on solutions of p-chlorotoluene in benzene, p-xylene and p-dichlorobenzene. The relaxation times and viscosities are examined in relation to molecular size and shape. A regular increase in relaxation time with increasing size of the substituted group is observed for the benzene derivatives with the exception of styrene. The anomalous values for the latter are attributed to planarity of the molecule. The slightly polar hydrocarbons are compared with the polar pyridines after suitable internal field and viscosity corrections have been applied to the latter. The ratios of the molecular relaxation times and viscosities at constant temperature, or equivalently, the molecular relaxation times at constant viscosity, are found to be adequate in most cases for correlation of compounds of different polarity but similar size and shape. A similar correlation is made for p-chlorotoluene between the pure liquid and its solutions in non-polar solvents whose molecular sizes and shapes are similar to the solute. Activation energies for viscous flow and dielectric relaxation are compared on the basis of molecular size and shape and the mechanism of each process. The difference between the two quantities is found to be a maximum for the nearly planar molecules and to decrease with increasing bulk and irregularity of the substituted group.

PRL08:014

Princeton U. Frick Chemical Lab., N. J.

THE DETERMINATION OF ATOMIC POLARIZATIONS AND DIPOLE MOMENTS FOR SLIGHTLY POLAR LIQUID HYDROCARBONS, by A. J. Petro and C. P. Smyth. July 10, 1957 [4]p. incl. tables, refs. (AFOSR-TN-57-362) (AF 18(600)1331) AD 132434 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 73-76, Jan. 5, 1958.

Dielectric constants, densities, and indices of refraction

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at five wave lengths have been measured for the pure liquids benzene, toluene, o-xylene, m-xylene, p-xylene, ethylbenzene, styrene and isopropylbenzene at 20, 40, and 60°. The electronic polarizations have been calculated by the Lorentz-Lorenz and Cauchy relationships and the total polarizations by the Clausius-Mosotti equation. The electronic polarizations have been found to be density dependent, but a plot of the difference between total and electronic polarizations against the reciprocal of absolute temperature has been found to yield a straight line whose intercept is the atomic polarization and whose slope is proportional to the dipole moment. Values obtained by this method using the Debye equation agree well with those obtained by microwave dielectric constant measurements for all except o-xylene and compounds of higher moments. The liquid and vapor dipole moments have been correlated with the asymmetry of the molecules. (Contractor's abstract)

PRL08:015

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXIII. THE DIELECTRIC RELAXATION TIMES AND DIPOLE MOMENTS OF SEVERAL ARYL ISOCYANATES AND RELATED COMPOUNDS, by B. R. Jolliffe and C. P. Smyth. Sept. 16, 1957 [3p. incl. tables, refs. (AFOSR-TN-57-563) (AF 18(600)1331) AD 160635 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 1064-1066, Mar. 5, 1958.

Dielectric constant and loss measurements at wave lengths of 577 m and 10.0, 3.22 and 1.25 cm have been carried out at 20, 40, and 60° upon dilute benzene solutions of phenyl isocyanate, phenyl isothiocyanate, p-tolyl isocyanate, tolylene-2,4-diisocyanate, 1-naphthyl isocyanate and 2-biphenylene isocyanate. The densities, viscosities and refractive indices of the solutions have also been measured. The molecular dipole moments calculated from these data indicate that the direction of the bond from the ring to the linear isocyanate group is close to, if not coincident with, that of the axis of the group. The dielectric data have been used to construct arc plots, from which the dielectric relaxation times and their almost negligibly small distribution parameters have been calculated. The rather large molecular relaxation times resulting from the considerable protrusion of the polar group from the ring are found to vary in the expected manner with the direction of the molecular dipole relative to the molecular axes. (Contractor's abstract)

PRL08:016

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXIV. THE DIELECTRIC RELAXATION OF LIQUID AMMONIA, by K. Fish, R. C. Miller, and C. P. Smyth. [1958] 6p. incl. table. (AFOSR-TN-58-324) (AF 18(600)1331) AD 154228 Unclassified

Also published in Jour. Chem. Phys., v. 29: 745-746, Oct. 1958.

Dielectric constant and loss measurements at wavelength of 3.22 and 1.24 cm have been carried out on liquid ammonia at temperatures from -55° to -35°C. The results have been used to calculate the approximate dielectric relaxation time values, 1.5×10^{-12} sec at -50° and 1.3×10^{-12} at -40°. The relaxation times and the liquid viscosities are much smaller than those of water, but extrapolation to the boiling point of the two liquids gives values of comparable magnitudes. (Contractor's abstract)

PRL08:017

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXV. MEASUREMENTS OF DIELECTRIC CONSTANT AND LOSS AT 3.1-MM WAVELENGTH BY AN INTERFEROMETRIC METHOD, by R. W. Rampolla, R. C. Miller and C. P. Smyth. Aug. 29, 1958, 27p. incl. diagrs. tables, refs. (AFOSR-TN-58-763) (AF 18(600)1331) AD 201862 Unclassified

Also published in Jour. Chem. Phys., v. 30: 566-573, Feb. 1959.

The theory and apparatus for an interferometric method for the measurement of the dielectric constant and loss of a liquid at 3.1-mm wavelength are described. The 3.1-mm wave is obtained as the fourth harmonic from a K-band reflex klystron. The probable error of the dielectric constant measurements is 0.5%, while that of the loss measurements is 2-5% for high loss liquids. For very low losses, only an upper limit can be obtained because of the small amount of harmonic energy obtainable. Four tetrahalogenated methanes, three substituted benzenes, two methylquinolines, three alcohols, and water have been measured and the results examined in the light of measurements at lower frequencies. All of the liquids but the three alcohols give 3-mm points lying satisfactorily on Cole-Cole arc plots drawn through points previously obtained at lower frequencies. The losses observed at 3-mm are, however, somewhat higher than that calculated indicating the probable presence of overlapping absorption regions at still higher frequencies. The apparent optical dielectric constant value 6.0

PRL 08:018; PRL 09:038, 039

found for water evidences further absorption at much shorter wavelengths. Methyl, ethyl, and n-octyl alcohols show absorption regions at frequencies too high to be attributable to molecular dipole orientation. The critical or maximum absorption wavelengths found for these additional high-frequency absorption regions are 0.57 cm for ethyl alcohol and 0.50 cm for n-octyl alcohol. (Contractor's abstract)

PRL 08:018

Princeton U. [Frick Chemical Lab.] N. J.

SHORTENING OF DIELECTRIC RELAXATION TIMES. AROMATIC METHOXY COMPOUNDS (Abstract), by D. M. Roberti and C. P. Smyth. [1958] [2]p. [AF 18(600)-1331] Unclassified

Presented at meeting of the Amer. Chem. Soc., Philadelphia, Pa., Feb. 5, 1958.

Dielectric relaxation studies on polar molecules have been extended to include molecules with rotating polar groups. Dielectric constant and loss were measured for a series of methoxy-substituted aromatic compounds over a range of temperatures and microwave frequencies. Data were used to calculate relaxation times, which were corrected for viscosity and internal field effects. These reduced relaxation times are compared with values for rigid molecules of similar size. Anisole, o-dimethoxybenzene, m-dimethoxybenzene, p-dimethoxybenzene, 1-methoxynaphthalene, and 2-methoxynaphthalene were studied as pure liquids, and the appropriate methyl- or ethyl-substituted compound used for comparison. In all cases, except for 1-methoxynaphthalene, the relaxation time is considerably shorter than would be expected, probably because of contribution to relaxation by an alternate mode of orientation, methoxy group rotation. With 1-methoxynaphthalene, a molecular model shows the methoxy group restricted in its rotation by the δ -hydrogen. With o-dimethoxybenzene, the data will not fit a Cole-Cole plot, and there is clear evidence for more than one dispersion region. Energies of activation for relaxation and for viscous flow are given and compared. High frequency intercepts on the Cole-Cole plots were used to calculate dipole moments.

PRL 09:038

Princeton U. James Forrestal Research Center, N. J.

FORCE AND MASS BALANCES OF THE INCOMPRESSIBLE, ISOTHERMAL, PLANAR LAMINAR JET ISSUING FROM A FINITE SOURCE, by A. L. Thomas. Dec. 1955, 17. Incl. illus. diagrs. tables, refs. (Technical note no. 31) (AFOSR-TN-57-21) (AF 33(038)23976) AD 115055. Unclassified

A mathematical solution to the velocity and concentration distributions of an incompressible, isothermal,

planar laminar jet issuing from a long rectangular slot into quiescent surroundings of the same density is presented. The features of the solution are: concentration and velocity distributions remain finite back to the orifice; the orifice is finite in dimensions; the change in concentration distribution (which is flat at the orifice), and the change in the velocity distribution (from the Poiseuille form at the orifice) are taken into account. The present solution for velocity distribution is a modification of that of Okabe who solved for the velocity distribution in a viscous jet for flow from a nozzle which provides a uniform velocity profile at the throat. Previous analyses of the planar, laminar jet assumed the jet to originate from a line source. Andrade reported experimental velocity distribution measurements of a laminar jet issuing from a nozzle under conditions similar to those specified by the theoretical studies of Okabe. The results of these two investigations are compared here after extension of numerical values of the essential parameters beyond those originally published. The solution for concentration distributions in the planar, laminar jet appears to be an initial one. A few experimental diffusion measurements have been performed along the centerline of the jet. The measurements indicate agreement with theory in the region of the orifice. The data were obtained from an ethylene-into-air jet. (Contractor's abstract)

PRL 09:039

Princeton U. James Forrestal Research Center, N. J.

A RELATIONSHIP BETWEEN SOME BOND PROPERTIES OF DIATOMIC MOLECULES AND THE IONIZATION POTENTIALS OF THEIR CONSTITUENT ATOMS, by B. Stevens. Mar. 1957 [16]p. Incl. tables, refs. (Technical note no. 34) (AFOSR-TN-57-194) (AF 33(038)23976) AD 126489 Unclassified

Also published in Spectrochimica Acta, v. 12: 154-161, Sept. 1958.

The relationship $kr_0^2/2 = N(I_A + I_B)$ between the force constant k , bond length r_0 and bond order N of the diatomic molecule AB in its ground state, and the first ionization potentials I_A and I_B of atoms A and B, is examined. For covalent molecules with 8, 10, or 11 valence shell electrons, the relationship is satisfactory, but for molecules with 2, 12, or 14 electrons in the valence shell the expression must be modified by the introduction of 2 constants. For molecules of this type the agreement between calculated and experimental bond lengths is as good as that obtained by Gordy, and the proposed expression has the theoretical advantage of equivalent dimensions. (Contractor's abstract)

PRL09:040 - PRL09:043

PRL09:040

Princeton U. [James Forrestal Research Center] N. J.

VIBRATIONAL ENERGY TRANSFER FROM COLLISIONAL DEACTIVATION OF SIMPLE MOLECULES AND FLUORESCENCE STABILIZATION OF COMPLEX MOLECULES, by E. Stevens and M. Boudart. [1957] [30]p. incl. diagrs. tables, refs. (AFOSR-TN-57-199) (AF 33(038)23976) AD 126496 Unclassified

Also published in Ann. New York Acad. Sciences, v. 67: 570-599, May 24, 1957.

A brief discussion is given of transfer for large quanta by acoustic vibrations. Experimental and theoretical work is described on fluorescence stabilization by diatomic and complex organic molecules such as aniline on the spectrum of H_2 , N_2 , CO_2 , NH_3 , and O_2 . Studies on 2-naphthylamine and aniline fluorescence quenching by CCl_4 are also described.

PRL09:041

Princeton U. [James Forrestal Research Center] N. J.

TURBULENT FLAME BLOW-OFF STABILITY. EFFECT OF AUXILIARY GAS ADDITION INTO SEPARATION ZONE, by F. Fetting, A. P. R. Choudhury, and R. H. Wilhelm. [1958] 24p. illus. diagrs. refs. (AFOSR-TN-58-467) (AF 33(038)23976) AD 158277

Unclassified

Also published in Seventh Symposium (Internat'l.) on Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, p. 621-632.

The work concerns flame blow-off limits at a 5 mm od cylindrical flame holder as the velocity of a premixed propane-air stream of different compositions is caused to increase to the condition of flame blow-off within a rectangular combustion chamber. Conditions are experimentally perturbed by gas and geometric changes to explore the blow-off process. Auxiliary combustible gases are found to raise the blow-off limit substantially for lean mixtures of the main premixed gas stream; O_2

acts in a like manner for rich mixtures. Inert gases tend to depress blow-off limits. The experiments indicate that a stabilizing ignition zone in a laminar flame is resident in the region near the burner lip in which streams of premixed combustible gases join and mix with convective streams of gas surrounding the burner. The resulting intermediate gas composition is characteristic only of the local zone and not of the adiabatic combustion wave farther distant.

PRL09:042

Princeton U. James Forrestal Research Center, N. J.

CHEMILUMINESCENCE IN THE SYSTEM ATOMIC SODIUM PLUS ATOMIC HYDROGEN, by J. D. McKinley, Jr. and J. C. Polanyi. [1958] [7]p. incl. diagr. table, refs. (AF 33(038)23976) Unclassified

Presented at Symposium on the Structure and Reactivity of Electronically-Excited Species, Ottawa U. (Canada), Sept. 5-6, 1957.

Published in Canad. Jour. Chem., v. 36: 107-113, Jan. 1958.

When atomic sodium is diffused into a mixture of atomic and molecular hydrogen, a weak chemiluminescence is observed in the gas phase. Visible emission consists of the sodium D lines. The total intensity of the emission, $\sim 5 \times 10^{11}$ photons/sec, indicates that only one in 5×10^4 of the sodium atoms entering the reaction vessel is involved in luminescent reaction. In order to account for the rapid fall-off in intensity of the flame away from the nozzle it is necessary to suppose that some non-luminescent reaction is removing sodium atoms in the gas phase. Preliminary experiments suggest that the non-luminescent reaction is $Na + H + H_2 \rightarrow NaH + H_2$, and the luminescent reaction either $Na + Na + H \rightarrow NaH + Na^*$ with collision yield 4×10^{-3} or $Na + H + H \rightarrow H_2 + Na^*$ with collision yield 1×10^{-5} . (Contractor's abstract)

PRL09:043

Princeton U. James Forrestal Research Center, N. J.

QUENCHING AND VIBRATIONAL-ENERGY TRANSFER OF EXCITED IODINE MOLECULES, by J. C. Polanyi. [1958] [10]p. incl. illus. diagr. table, refs. (AF 33(038)-23976) Unclassified

Presented at Symposium on the Structure and Reactivity of Electronically-Excited Species, Ottawa U. (Canada), Sept. 5-6, 1957.

Published in Canad. Jour. Chem., v. 36: 121-130, Jan. 1958.

Quenching of I_2^* ($^3\Pi_{0u}^+$) ($\nu^* = 26$) is shown to take place to the exclusion of vibrational-energy transfer in iodine at pressures up to 19 mm. A possible quenching mechanism involving sensitized predissociation of the collision partner is described. Vibrational transfer in collisions with H_2 and D_2 is found to occur at less than every gas kinetic collision. Arguments on general grounds are put forward to support this result, which conflicts with that of earlier workers. Increase in the mass of the isotope is found to bring about increased efficiency of vibrational transfer.

PRL10:011 - PRL10:016

PRL10:011

Princeton U. James Forrestal Research Center, N. J.

A MATHEMATICAL ANALYSIS OF THE SOURCES OF ERROR IN DIFFUSION STUDIES USING TRACERS, by R. H. Condit. Feb. 1957 [21]p. incl. diagrs. tables. (Metallurgy rept. no. 11) (AFOSR-TN-57-109) (AF 18-600)967 AD 120461 Unclassified

A mathematical analysis of the sources of error in solid diffusion studies using radioactive tracers is presented with a table of the accuracies necessary in the experimental variables to achieve some desired accuracy in the diffusion coefficient. Ways are formulated for estimating the amount of tracer required for a diffusion run, and criteria for choosing between sectioning and residual activity methods suggested. (Contractor's abstract)

PRL10:012

Princeton U. James Forrestal Research Center, N. J.

HIGH TEMPERATURE OXIDATION OF IRON-NICKEL ALLOYS, by M. J. Brabers and C. E. Birchenall. Mar. 25, 1957 [22]p. incl. illus. diagrs. tables, refs. (Metallurgy rept. no. 12) (AFOSR-TN-57-150) (AF 18(600)967) AD 126439 Unclassified

Also published in *Corrosion*, v. 14: 179t-182t, Apr. 1958.

The iron-rich corner of the phase diagram for the Fe-Ni-O has been determined at 1050°C. Great care was taken to assure equilibration which was not completely achieved in an earlier study. The mechanism of oxidation of iron-nickel alloys is discussed and a protective mechanism is described which differs somewhat from those suggested for other alloys.

PRL10:013

Princeton U. James Forrestal Research Center, N. J.

KINETICS OF THE OXIDATION OF WÜSTITE AND MAGNETITE, by J. D. Mackenzie and C. E. Birchenall. July 23, 1957 [18]p. incl. diagrs. table. (Metallurgy rept. no. 13) (AFOSR-TN-57-451) (AF 18(600)967) AD 136441 Unclassified

A method has been developed for the bulk preparation of solid homogeneous wüstite of controllable oxygen content. The reaction rates of wüstite and magnetite with oxygen at atmospheric pressure over the temperature range 700° to 1000°C have been measured by a gravimetric method and the products examined by x-ray and metallographic techniques. The effect of the oxygen content of the non-stoichiometric wüstite on the reaction rates has also been studied. Results obtained for the

growth of thick layers of the higher oxides of iron are discussed in terms of the common rate laws. (Contractor's abstract)

PRL10:014

Princeton U. James Forrestal Research Center, N. J.

A REDETERMINATION OF THE LEAD-LEAD SULFIDE EQUILIBRIUM BETWEEN 620° AND 920°C, by J. R. Stubbles and C. E. Birchenall. May 16, 1958 [9]p. incl. diagr. table. (Metallurgy rept. no. 18) (AFOSR-TN-58-470) (AF 18(600)967) AD 158281 Unclassified

The equilibrium between lead, lead sulfide and circulating atmospheres of hydrogen and hydrogen sulfide have been measured and analyzed between 820° and 920°C by an iodimetric back-titration method. The data may be represented by a linear free energy equation $\Delta G^\circ = 17,060 + 8.84T$ cal, whose enthalpy and entropy terms have associated errors of ± 1 kcal and ± 1 eu. Reasons are given for accepting the new data in preference to that which already exists. (Contractor's abstract, modified)

PRL10:015

Princeton U. James Forrestal Research Center, N. J.

METAL-GAS REACTIONS, by C. E. Birchenall. May 31, 1958 [12]p. incl. diagr. refs. (Metallurgy rept. no. 17) (AFOSR-TN-58-471) (AF 18(600)967) AD 158282 Unclassified

Also published in *Conf. on the Kinetics of High-Temperature Processes*, Massachusetts Inst. of Tech., Cambridge (June 23-27, 1958), Cambridge, Technology Press, 1958, p. 277-281.

Some aspects of reactions between metals and their gaseous environments which are responsible for deviations from simple kinetic equations are discussed, including dissolution and diffusion of gases, formation of volatile, solid and liquid products, and cracking of metal scale. Specific instances are pointed out in which incomplete observations may allow faulty interpretations. An attempt is made to distinguish those problems which are ready for systematic investigation from those which are too complex for our present techniques and models to handle. (Contractor's abstract, modified)

PRL10:016

Princeton U. James Forrestal Research Center, N. J.

SELF-DIFFUSION OF IRON IN NICKEL AND COBALT FERRITES, by R. H. Condit, M. J. Brabers, and C. E. Birchenall. July 1958 [9]p. incl. diagrs. (Metallurgy rept. no. 18) (AFOSR-TN-58-565) (AF 18(600)967) AD 158383 Unclassified

PRI 10:017; PRI 11:206-208

The self-diffusion of radioactive iron has been measured in nickel and cobalt ferrites in the temperature range between 844° and 1190°C. The rate of diffusion in the nickel ferrite is lower by about an order of magnitude than the diffusion in magnetite, and the rate in cobalt ferrite is about two orders of magnitude lower than the diffusion in magnetite. Iron diffusion in nickel ferrite appears to decrease with decreasing iron content. (Contractor's abstract)

PRI 10:017

Princeton U. James Forrestal Research Center, N. J.

CONDUCTIVITY AND THERMOELECTRIC POWER OF FeO (Abstract), by A. B. Kuper. [Mar. 1957] [1]p. (AF 18(600)967) Unclassified

FeO polycrystals were made by complete oxidation of 99.95 iron in hydrogen-water vapor followed by homogenization in the same atmosphere and rapid quench. Four compositions spanning the phase range at high temperature were used: Fe_{0.916}O to Fe_{0.951}O corresponding respectively to 4.9% to 8.4% Fe⁺⁺ vacancies. Measurements were made from 77 - 360°K. The alloy tends to decompose at somewhat higher temperature. The thermoelectric power (Q) is positive. QT increases with T with plateaus which depend on composition at roughly .007 and .02 ev. Assuming QT = E_F the Fermi energy, then the number of holes changes relatively little over the T range. The conductivity, $\sigma \approx \sigma_0 \exp\left(\frac{-0.1 \text{ ev.}}{RT}\right)$ and shows some composition dependence. σ at room temperature $\approx 1 \text{ (ohm-cm)}^{-1}$. The number of acceptors is assumed to be one per Fe⁺⁺ vacancy since each such vacancy is neutralized at low temperature by two localized holes. At room T the mobility is $10^{-3} \text{ cm}^2/\text{v-sec}$. It is assumed that conduction takes place by diffusion of holes between localized Fe d-levels.

Princeton U. James Forrestal Research Center, N. J. (Project SQUID)

PRI 11:206

Johns Hopkins U. Baltimore, Md.

NON-LINEAR INTERACTIONS IN A VISCOUS HEAT CONDUCTIVE COMPRESSIBLE GAS, by B.-T. Chu and L. S. G. Kovasznay. June 1957, 51p. Incl. table, refs. (Proj. Squid technical rept. no. JHU-15-P) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1121, Office of Naval Research under N6ori-10503, and Bureau of Ordnance under NORD-15872) AD 133051 Unclassified

Princeton U. James Forrestal Research Center, N. J. (Project SQUID)

Also published in Jour. Fluid Mech., v. 3: 494-514, Feb. 1958.

The linearized equations of motion show that 3 basic modes of fluctuations exist in a viscous, heat-conductive, compressible medium. The nonlinearity of the governing equations can be interpreted as an interaction among 3 basic modes. These interactions are classed as "mass-like", "force-like", or "heat-like" effects. A system evolving interactions of an arbitrary order is presented, and the second-order (bilateral) interactions are investigated in detail. A method of estimating the relative importance of the different second-order interactions is illustrated by means of an example, and some predictions are made about the general behavior of the flow. (Contractor's abstract)

PRI 11:207

Johns Hopkins U., Baltimore, Md.

ON THE FINE STRUCTURE OF TURBULENT FLOWS, by R. Betchov. [1957] [12]p. Incl. diagrs. refs. (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Office of Ordnance Research under N6ori-10503) Unclassified

Published in Jour. Fluid Mech., v. 3: 205-216, Nov. 1957.

The turbulence produced by a multiplicity of small air jets has been investigated and comparisons are made with other turbulent flow. The eddy Reynolds number is large ($R_\lambda = 250$). The energy spectrum was measured, as well as the skewness and kurtosis of $\partial u/\partial x$. The effect of the finite length of the hot wire is considered, and the corrected results indicate that the spectrum follows the law of Kolmogoroff in an intermediate range and appears to fall off with the (-6)-power of the frequency in the viscous range. This range is limited at the upper end of the frequency range by electrical noise. Special precautions reduced this noise to the level of thermal agitation in the hot wire. The ultimate limit to spectral analysis is imposed by the molecular agitation of the gas. This limit is evaluated and compared with the spectrum of turbulence. It appears that the spectrum of $\partial^3 u/\partial x^3$ merges with the spectrum of molecular agitation without a distinctive separation. (Contractor's abstract)

PRI 11:208

Johns Hopkins U., Baltimore, Md.

ON UNSTEADY INTERACTION BETWEEN A WEAK THERMAL LAYER AND A STRONG PLANE OBlique

PRI.11:209 -PRI.11:211

Princeton U. James Forrestal Research Center, N. J.
(Project SQUID)

SHOCK, by C.-T. Chang. [1958] [7]p. incl. diagrs.
(Sponsored jointly by Office of Naval Research, Air
Force Office of Scientific Research, and Office of Ordnance
Research under N6ori-10503) Unclassified

Published in Jour. Aeronaut. Sciences, v. 25: 317-323,
May 1958.

A problem of unsteady interaction between a weak up-
stream temperature disturbance and a plane oblique
shock is investigated. The shock is assumed to be
located at the concave corner of a wall. The tempera-
ture disturbance is taken as a layer of hot air of constant
strength — namely, a step function. Its wave front is
inclined at a definite angle with respect to the upstream
unperturbed flow. It is found for such a configuration
that, even for weak upstream disturbance, mixed flow
(a supersonic region outside and a subsonic region in-
side a sonic circle, respectively) usually occurs down-
stream of the shock. Using a general concept of conical
flow, the qualitative nature of the flow field down-
stream is predicted. Subsequently, a method for its
quantitative investigation is presented. Based on the
concept of constant states, the flow in the supersonic
region is determined by the method of characteristics;
the flow in the subsonic region is determined by follow-
ing a procedure similar to the one used by Lighthill in
his investigation about the diffraction of blast waves.
(Contractor's abstract)

PRI.11:209

Johns Hopkins U. Applied Physics Lab., Baltimore, Md.

VORTICITY PRODUCTION IN ISOTROPIC TURBU-
LENCE, by R. Betchov. [1957] [9]p. incl. refs. (Spon-
sored jointly by Office of Naval Research, Air Force
Office of Scientific Research, and Office of Ordnance
Research under N6ori-10503) Unclassified

Published in Proc. Ninth Internat'l. Congress of Appl.
Mech., Brussels (Belgium) (Sept. 5-13, 1956), v. 3:
405-413, 1957.

An essential aspect of turbulence is the presence of
vorticity fluctuations. In isotropic, homogeneous and
incompressible flow, they are tied to the energy dissipa-
tion and the rate of deformation of small fluid
spheres. In a suitable non-dimensional form, the time
derivative of the mean square of the vorticity is given
by:

$$\frac{d}{dt} \overline{\omega^2} = \frac{35}{8} S - D^2$$

where the skewness S represents non-linear inertial
effects and where D^2 represents viscous effects. Ex-

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perimentally S is found positive. With Helmholtz theo-
rem, this indicates concentration of vorticity in narrow
regions. S has been measured accurately and found to be
equal to 0.4 ± 0.05 , irrespective of the turbulence
Reynold's number. Under the usual assumptions of iso-
tropy, homogeneity and incompressibility and using only
first derivatives of the velocity, the following has been
found:

$$-0.436 \gamma^{1/2} < S < 0.436 \gamma^{1/2}$$

where γ is a kurtosis. With $\gamma = 4$ a kinematic maximum
 $S = 0.87$ has been found. The dynamic equations involve
second derivatives and they tend to lower the maximum
value of S. Thus the observed value should correspond
to a dynamic maximum. Other kinematic considerations
show that when S is positive, the mean rate of deforma-
tion of small fluid spheres corresponds to squashing and
not stretching of the spheres. Consequently the stretching
of the vorticity occurs along the two minor principal axis
of the rate of strain tensor. (Contractor's abstract)

PRI.11:210

Massachusetts Inst. of Tech., Cambridge.

RADIANT HEAT EXCHANGE IN A GAS-FILLED
ENCLOSURE, by H. C. Hottel and E. S. Cohen. Aug.
1957, 1v. incl. illus. (Proj. Squid technical rept. no.
MIT-14-P) (Sponsored jointly by Office of Naval Re-
search, Air Force Office of Scientific Research, and
Office of Ordnance Research under N6ori-10503)
AD 138820 Unclassified

Presented at ASME-AiChE Heat Transfer Symposium,
Pennsylvania State U., University Park, Aug. 12, 1957.

A method is presented for predicting radiant heat inter-
change in enclosures where allowance is to be made for
gas temperature variation. A set of reception factors
permit evaluation of any exchange problem in which the
geometry is represented in Cartesian coordinates.
This new method may be used on a particular model or
class of furnaces in comparison with various engineering
shortcuts, to determine the range over which one of the
latter may be relied upon. The evaluations of the recep-
tion factors, and ψ , the fraction of the energy originating
within the cube which leaves the boundaries of the cubes,
are appended.

PRI.11:211

Massachusetts Inst. of Tech. Fuels Research Lab.,
Cambridge.

APPLICATION OF WELL-STIRRED REACTOR
THEORY TO THE PREDICTION OF COMBUSTOR

PRL11:212 - PRL11:214

Princeton U. James Forrestal Research Center, N. J.
(Project SQUID)

PERFORMANCE, by H. C. Hottel, G. C. Williams, and A. H. Bonnell. June 1957, 27p. illus. (Proj. Squid technical rept. no. MIT-15-P) (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Office of Ordnance Research under N6ori-10503) AD 135111 Unclassified

Also published in Combustion and Flame, v. 2: 13-34, Mar. 1958.

The implications of well-stirred reactor kinetics in the prediction of combustion-chamber performance were examined. The gross performance characteristic of a combustion chamber can be simulated by models which are built up from interactive, well-stirred reactor elements. Three models which were examined analytically show (1) the effect of pressure interaction; (2) the effect of recirculation interaction; and (3) the effect of a non-uniform distribution of fuel-air ratio. Instability phenomena in a simple combustion system were experimentally investigated; preliminary results indicate that models which are based on the well-stirred reactor are capable of providing a basis for models of high-output combustion.

PRL11:212

Princeton U., N. J.

THERMAL CONDUCTIVITY OF PURE LIQUIDS, by W. J. Scheffy and E. F. Johnson. Aug. 1957, 19p. illus. tables, refs. (Proj. Squid technical rept. no. PR-71-M) (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Office of Ordnance Research under N6ori-10503) AD 142428 Unclassified

Efforts are being directed toward predicting empirically thermal conductivity in its variation with molecular weight, density, and temperature. A general correlation of thermal conductivity is described which is based on limited theoretical and inadequate experimental data, but which has advantages of simplicity and ease of application. A cylindrical apparatus was constructed for reasonably accurate determinations of thermal conductivity of liquids between room temperature and their boiling points. Temperature profiles were obtained without simultaneous longitudinal gradients on the heater tube and the wall separating the test section and the sand bed. By using the known conductivities of H_2O and CCl_4 ,

the following equation was obtained for the thermal conductivity of a test liquid for a temperature of $25^\circ C$ in the cooling jacket: $k_L = \frac{26.24}{m} + 0.314$, where m is the

slope of the curve of ΔT_L versus ΔT_S for the test

liquid at various heat fluxes. Results of runs on MeOH, benzene, chlorobenzene, and allyl alcohol are compared.

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The apparatus appeared to be capable of yielding reliable results with fairly good reproducibility. A high-temperature apparatus was developed to obtain data on Me_2CO , benzene, ETOH, *tert*-BuOH, glycerol, and 2 silicone fluids; thermal conductivity data are tabulated.

PRL11:213

Princeton U., N. J.

A MULTIPLE RANGE VISCOMETER FOR LIQUIDS, by E. F. Johnson, P. E. Parisot, and D. R. MacRae. Aug. 1957 [11]p. incl. illus. table. (Proj. Squid technical rept. no. PR-72-M) (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Office of Ordnance Research under N6ori-10503) AD 142429 Unclassified

A multiple-range capillary-type viscometer was developed which is capable of reliable measurements at temperatures up to $300^\circ C$ and at pressures up to 100 atm. The viscometer consists of an auxiliary apparatus for generating and measuring flows and pressure drops and of a constant temperature bath and temperature measuring apparatus. The viscometer was tested with hexane between 25° and $200^\circ C$. The precision of measurement was better than $\pm 0.5\%$, and absolute accuracy was better than $\pm 2\%$. The theoretical basis of operation is discussed.

PRL11:214

Princeton U. James Forrestal Research Center, N. J.

BIBLIOGRAPHY OF UNCLASSIFIED SQUID PUBLICATIONS. SUPPLEMENT "A" JUNE 1, 1956 - JUNE 1, 1957. Oct. 1957, 13p. refs. (Proj. Squid technical rept. no. PR-67-P-A; Suppl. to technical rept. no. PR-67-P (item no. PRL11:179) (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Office of Ordnance Research under N6ori-10503) AD 146062 Unclassified

This bibliography is supplementary to the bibliography which appeared in Jet Propulsion, v. 26: 660-680, Aug. 1956, under the title "Ten Years of Project Squid" (item no. PRL11:179). All of the papers appeared as Squid reports dated later than June 1, 1956 except for several from the Bureau of Mines which inadvertently were not included in the first bibliography.

FRL 11:215; PRI 20:001-003

Princeton U. James Forrestal Research Center, N. J.
(Project SQUID)

PRI 11:215

Purdue U., Lafayette, Ind.

THE DETERMINATION OF HEAT TRANSFER COEFFICIENTS FOR AIR AND CARBON DIOXIDE, by E. L. Katz. May 1957, 22p. incl. illus. refs. (Proj. Squid technical rept. no. PUR-33-P) (in cooperation with Consolidated Vultee Aircraft Corp., San Diego, Calif.) (Sponsored jointly by Office of Naval Research, Air Force Office of Scientific Research, and Office of Ordnance Research under N6ori-10503) AD 129599

Unclassified

Presented at Diamond Jubilee annual meeting of the Amer. Soc. Mech. Engineers, Chicago, Ill., Nov. 13-18, 1955.

An experimental investigation was conducted for determining the convection and radiation heat-transfer coefficients for pure dry air and pure gaseous carbon dioxide flowing turbulently through a small-diameter, water-cooled tube. The experimental results are correlated with an average deviation of $\pm 8\%$ by the following equation:

$$j = 0.035 Re^{-0.23}$$

wherein all physical properties are evaluated at the average film temperature. Data were obtained over a static gas pressure range of 50 to 250 psia, an average gas bulk temperature range of 597 to 1778F, and a Reynolds number range of 8300 to 140,000. The total heat-transfer coefficients for carbon dioxide, which contain both radiation and convection components, are shown to be numerically less than the pure convective coefficients for air at the same conditions of temperature, pressure, and Reynolds number. The total coefficients for CO_2 are shown to be affected by pressure

at high bulk temperatures. For example, the total coefficient decreased 9% when the pressure was increased from 50 to 200 psia. (Contractor's abstract)

PRI 20:001

Princeton U. Palmer Physical Lab., N. J.

FEYNMAN GELL-MANN THEORY OF FERMION INTERACTIONS, by M. L. Goldberger and S. B. Treiman. [1958] [5]p. (AFOSR-TN-58-399) [AF 49(638)304] AD 154308

Unclassified

Also published in Phys. Rev., v. 110: 1478-1479, June 15, 1958. (Title varies)

In analogy with the proposed self-interacting conserved vector current used to explain the almost precise equality

of the vector coupling strengths in β and μ decay, a self-interacting conserved axial vector current has been proposed to explain the near equality of the axial vector strengths in the same two decays. In order to explain the decay of strange particles a strangeness non-conserving current has also been proposed. It is shown that both the axial vector current and the strangeness non-conserving current are ruled out on experimental grounds.

PRI 20:002

Princeton U. Palmer Physical Lab., N. J.

NEUTRAL PION DECAY, by M. L. Goldberger and S. B. Treiman. [1958] [13]p. (AFOSR-TN-58-400) (AF 49(638)304) AD 154309

Unclassified

Also published in Nuovo Cimento, Series X, v. 9: 451-460, Aug. 1, 1958.

Dispersion relations are used to study the decay of neutral pions through baryon pairs, which annihilate to produce photons. Nucleon pairs are taken to be representative of baryon pair contributions generally. The final expression for the decay rate has a structure very different from that obtained from perturbation theory. However, it turns out that the numerical results are not appreciably different. (Contractor's abstract, modified)

PRI 20:003

Princeton U. Palmer Physical Lab., N. J.

ELECTROMAGNETIC STRUCTURE OF THE NUCLEON, by P. Federbush, M. L. Goldberger, and S. B. Treiman. [1958] [69]p. incl. diagr. tables, refs. (AFOSR-TN-58-499) [AF 49(638)304] AD 158309

Unclassified

Also published in Phys. Rev., v. 112: 642-665, Oct. 15, 1958.

The electromagnetic structure of the nucleon is studied using dispersion relation techniques. Contributions to the magnetic moments and mean-square radii from the two pion intermediate state are studied exhaustively. It is shown that the electromagnetic structure of the meson itself may play an important role. The structure of the meson is also discussed. The two pion state seems to account reasonably for the isotopic vector magnetic moment and magnetization mean-square radius, but the charge density radius appears to be much smaller than the currently accepted experimental value. As regards the isotopic scalar properties of the nucleon, study is made of the contributions from intermediate states with two K-mesons and nucleon-antinucleon pairs (more generally baryon pairs). The K-meson state is treated by perturbation theory and found to have a small effect. Using an argument based on the unitarity of the S-matrix it is shown that the pair contributions must be small.

AIR FORCE SCIENTIFIC RESEARCH

PRO.20:004; PRO.01:003, 004
PRO.02:001, 002

Certain general properties of the three pion state, believed to be the most important contributor to isotopic scalar quantities, are discussed. (Contractor's abstract, modified)

PRO.004

Section U. Palmer Physical Lab., N. J.

A SOLUBLE PROBLEM IN DISPERSION THEORY, by M. L. Goldberger and S. B. Treiman. [1958] [7]p. (AFOSR-TN-58-1017) (AF 49(638)304) AD 162282

Unclassified

Published in Phys. Rev., v. 113: 1663-1669, Mar. 15, 1959.

The Lee model is modified by addition of a new field θ' and a weak coupling $N + \theta \rightarrow N + \theta'$, which leads to instability of the V particle: $V \rightarrow N + \theta \rightarrow N + \theta'$. The decay amplitude is calculated to lowest order in the weak coupling by dispersion relation methods. In effect we are required to study a set of simultaneous dispersion relations. The problem is completely soluble and serves to clarify the essential structure of dispersion methods. The results agree with what one obtains, more easily in the present case, by direct methods. (Contractor's abstract)

PRO.01:003

Propulsion Research Corp., [Santa Monica] Calif.

NUMERICAL ANALYSIS OF INVISCID SUPERSONIC FLOWS, UTILIZING THE STREAMSURFACE CHARACTERISTICS METHOD, by C. Cobb, H. G. Loos, and S. Manus. Jan. 1958, 31p. Incl. diagrs. (Rept. no. R-270) (AFOSR-TN-58-105) (AF 18(600)1143) AD 152014

Unclassified

The streamsurface characteristics method for supersonic flow mentioned in item no. PRO.01:002 has been programmed for the IBM-650 digital computer. As a result, the isentropic supersonic flow between two close surfaces of arbitrary but regular shape, subject to proper boundary conditions, can be determined at a speed of about 1 3/4 minutes per point. The IBM-650 computer was found to be somewhat too small for the present problem. The numerical examples involving internal supersonic flow problems are given. (Contractor's abstract)

PRO.01:004

Propulsion Research Corp., Santa Monica, Calif.

EXPERIMENTAL INVESTIGATION OF A THREE DIMENSIONAL ALL SUPERSONIC DIFFUSING CASCADE,

by T. Iura and E. Beder. May 1958, 175p. Incl. illus. diagrs. tables, refs. (Rept. no. R-288) (AFOSR-TR-58-132) (AF 18(600)1143) AD 203712; PB 142012

Unclassified

A three-dimensional all-supersonic diffusing cascade was designed by the stream surface characteristics method and tested in a wind tunnel over the Mach number range 2.2 to 3.0. Stable supersonic flow was established over a wide range of incidence angles. Chordwise blade-surface static pressures, exit-plane pitot surveys, and Schlieren photographs were obtained. (Contractor's abstract)

PRO.02:001

Propulsion Research Corp., Santa Monica, Calif.

ESCHER WYSS CLOSED CYCLE AIRCRAFT POWER-PLANT STUDY. PART I. SUMMARY AND EVALUATION OF PHASE I, by R. D. Buhler. May 8, 1957, 58p. Incl. diagrs. tables. (Rept. no. R-258) (AFOSR-TR-57-30) (AF 18(603)27) AD 126569

Unclassified

Various ducted fans driven by closed cycle gas turbines were studied. For chemical fuels, two arrangements were considered for the combustion chamber containing the closed cycle gas heater: (a) as part of a separate turbojet engine ("external heat source"), and (b) as an afterburner in the ducted fan air flow ("self contained closed cycle engines"). For nuclear fuels the high-temperature gas-cooled reactor was considered the most likely heat source ("single loop system"). One closed cycle power-plant with external gas heater was fairly completely designed. The component weights of this engine were used as a basis for weight estimates of the other engines. Two other closed cycle applications were briefly investigated: a high altitude secondary power-plant, and a boundary layer suction fan drive system. The closed cycle ducted fans using chemical fuels were found to be too heavy and complicated to be competitive with open cycle engines. The gas-cycle nuclear engine looked promising for subsonic and possibly for low supersonic propulsion. Further work on this was initiated. As secondary powerplants for future high altitude flight vehicles, closed cycle turbines promise to have a definite field of application. (Contractor's abstract)

PRO.02:002

Propulsion Research Corp., Santa Monica, Calif.

ESCHER WYSS CLOSED CYCLE AIRCRAFT POWER-PLANT STUDY. PART II. INTERIM SUMMARY AND EVALUATION OF PHASE II, by R. D. Buhler. May 10, 1957, 43p. Incl. diagrs. table. (Rept. no. R-259) (AFOSR-TR-57-37) (AF 18(603)27) AD 126570

Unclassified

A portion of a study on closed cycle gas turbine for

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AIR FORCE SCIENTIFIC RESEARCH

PRO.03:001, 002; PRO.04:001, 002
PSY.01:001

aircraft has been summarized and evaluated. This study dealt with closed cycle turbine-ducted fan powerplants suitable for a gas-cooled reactor heat source. The reactor-gas turbine loop would use helium, at a turbine inlet condition of about 70 atm and 1800°F. Cycle calculations with and without a regenerator show a potential heat consumption at sea level static conditions of

$7.5 - 12.2 \times 10^3$ Btu/hr - 1 lb thrust (equivalent to an sfc of 0.42 - 0.68 for hydrocarbon fuels), and an air specific impulse of about 30 with a 1.6:1 pressure ratio fan. The regenerator would be extremely compact, about 1.6 cu ft/hp, the cooler rather bulky, about 30 cu ft/hp, but not excessively heavy. The cooler and regenerator together would weigh about 0.13 lb/hp. The closed cycle turbomachinery would be extremely small, favoring the design of larger power units (above 15,000 hp). The high speed capabilities of these engines as well as mechanically advantageous arrangements and overall weight estimates are currently being worked on. (Contractor's abstract)

PRO.03:001

Propulsion Research Corp., Santa Monica, Calif.

ANALYTICAL COMPARISON STUDY OF THE PRC WAVE ENGINE AND SOME COMPETITIVE AIR-BREATHING ENGINES. Jan. 1958, 50p, incl. illus. diagrs. (Rept. no. R-280) (AFOSR-TR-58-36) (AF 18-603)77) AD 152245
Unclassified

The performance of the PRC wave engine has been calculated and has been compared with those of two turbojets and a ramjet. It is concluded that the PRC wave engine does not have a lower specific fuel consumption than existing competitive engines. The thrust per frontal area for the wave engine in supersonic flight was found to be about one-third of the value for a turbojet with afterburner. (Contractor's abstract)

PRO.03:002

Propulsion Research Corp., Santa Monica, Calif.

PRELIMINARY DESIGN STUDY OF THE PRC WAVE ENGINE. Feb. 1958 (30)p, incl. diagrs. (Rept. no. R-284) (AFOSR-TR-58-55) (AF 18(603)77) AD 154207
Unclassified

Preliminary design studies were made of the PRC wave engine and a configuration was selected for a model engine to conduct feasibility tests and to determine mechanical problems and real fluid effects associated with this type of engine. Initial layouts were completed for the engine and test rig, and are presented in this report. (Contractor's abstract)

PRO.04:001

Propulsion Research Corp., Santa Monica, Calif.

POTENTIAL AIRCRAFT APPLICATIONS OF CLOSED GAS CYCLE NUCLEAR POWER PLANTS, by R. D. Buhler and P. J. Gingo. Dec. 1957, 48p, incl. illus. diagrs. tables, refs. [Rept. no. TM-84] (AF 49(638)38)
Unclassified

Also published in Proc. Symposium on Advanced Propulsion Systems, Los Angeles, Calif. (Dec. 11-13, 1957), N. Y., Pergamon Press, v. 2: 117-134, 1959.

Closed gas-cycle nuclear power plants for aircraft applications are currently being re-evaluated in view of recent advances in refractory metals and ceramic fuel element technology. With high-pressure helium as the primary loop working fluid, the chief advantages of the closed-cycle gas-cooled systems are (1) compact reactor, (2) high cycle efficiency, (3) freedom from corrosion, and (4) high physical and nuclear stability of the working fluid. Heat exchanger sizes, weights and tightness, together with the possibility of fission product leakage into the helium, are currently considered as the most severe problems. Neither the size, weight, nor performance of the helium turbomachinery is expected to pose any serious difficulties. The performance of a subsonic-supersonic dash airplane with chemical fuel augmentation, was calculated using material temperatures compatible with present day technology. Two other airplanes, which were all supersonic and which used a nuclear power plant system during their entire mission, were studied. A preliminary study of the possible space vehicle applications of closed gas-cycle systems has also been started. (Contractor's abstract)

PRO.04:002

Propulsion Research Corp., Santa Monica, Calif.

STUDY AND EVALUATION OF CLOSED CYCLE GAS TURBINE PROPULSION SYSTEMS WITH NUCLEAR HEAT SOURCE (Unclassified title). (n.a.) Apr. 9, 1958, 153p, incl. illus. diagrs. tables, refs. (Rept. no. R-283) (AFOSR-TR-58-76) (AF 49(638)38) AD 158340
Secret

PSY.01:001

Psychological Research Associates, Arlington, Va.

A FRAMEWORK FOR INTEGRATION OF SMALL GROUP RESEARCH STUDIES. A PILOT STUDY, by J. E. McGrath. Oct. 1957, iv, incl. tables, refs. (PRA rept. no. 57-20) (AFOSR-TR-57-87) (AF 49(638)47) AD 136680; PB 135595
Unclassified

A pilot study is presented relative to the development of a tentative framework for integration of small group

PRF.01:007 - PRF.01:010

research knowledge, and the application of this framework to a sample of studies. A working bibliography of 1279 items is compiled. The classification procedures are discussed which are applied to annotating the bibliography of the developmental sample. Two classification systems at 2 levels of abstraction are described; a syntactical framework for classification of studies by types, and a set of procedures for compiling research information within studies of a given type. Summaries are given of the studies of the developmental sample. (Contractor's abstract)

PRF.01:007

Purdue Research Foundation, Lafayette, Ind.

ON A LEMMA IN THE DIRECT METHOD OF THE CALCULUS OF VARIATIONS, by L. Cesari and L. H. Turner. Dec. 1956, 8p. (Technical note no. 6) (AFOSR-TN-57-245) (AF 18(600)1484) AD 126542

Unclassified

Also published in Rend. Circ. Matem. Palermo, Series II, v. 6: 109-113, Jan.-Apr. 1957.

Some years ago, Cesari (Amer. Jour. Math., v. 74: 265-275, 1952) improved very beautifully a smoothing process for surfaces, with the help of a simple integral inequality, of which the published proof is adapted to establish a more general inequality with four exponents. (An unpublished simpler calculus proof results from subsequent conversations with the authors.) (Math. Rev. abstract)

PRF.01:008

Purdue Research Foundation, Lafayette, Ind.

A FINE CYCLIC ADDITIVITY THEOREM OF A FUNCTIONAL, by C. J. Neugebauer. Apr. 1957, 13p. (Technical note no. 9) (AFOSR-TN-57-249) (AF 18(600)1484) AD 126547

Unclassified

Also published in Illinois Jour. Math., v. 2: 396-401, Sept. 1958.

A closed finitely connected Jordan region J with (T, J) a continuous mapping from J into E_3 . A study is made of a generalization of Cesari's fine cyclic additivity theorem of the Lebesgue area. Non-negative functionals Φ are defined for each continuous mapping T from a Peano space F into a metric space P^* . $T = sf, f: P \rightarrow M, s: M \rightarrow P^*, r(M) < \infty$ is an unrestricted factorization of T and Γ is the collection of fine cyclic elements of M . A connected open set $G \subset M$ containing and associ-

ated with Γ such that Γ is a local A-set relative to G . t_Γ is the natural retraction from G_Γ onto Γ , and $A_\Gamma = f^{-1}(G_\Gamma)$. It is proved that $\Phi(T, P) = \Sigma \Phi(st_\Gamma f, A_\Gamma)$, $\Gamma \subset M$.

PRF.01:009

Purdue Research Foundation, Lafayette, Ind.

LOCAL A-SETS, B-SETS, AND RETRACTIONS, by C. J. Neugebauer. Apr. 1957, 20p. (Technical note no. 8) (AFOSR-TN-57-250) (AF 18(600)1484) AD 126548

Unclassified

Also published in Illinois Jour. Math., v. 2: 386-395, Sept. 1958.

A concept of retraction of a Peano space onto one of its B-set is introduced with the complement of the B-set mapped into a dendrite. A local A-set of a Peano space is introduced and a local A-set B is an A-set relative to a connected open set G of P , i.e., B is a non-degenerate compact subset of P such that every component of $G-B$ has a single frontier point relative to G . A natural retraction from G onto B suggests itself, i.e., the one that sends each component of $G-B$ into its frontier relative to G . It is asserted that this retraction t can be extended to P so as to map $P-B$ into a dendrite. The composition of two retractions is analyzed. It is seen that every local A-set is a B-set, and if the underlying Peano space is of finite degree of multicoherence, every B-set is a local A-set.

PRF.01:010

Purdue Research Foundation, Lafayette, Ind.

A DECOMPOSITION OF A PEANO SPACE, by C. J. Neugebauer. Apr. 1957, 7p. (Technical note no. 7) (AFOSR-TN-57-251) (AF 18(600)1484) AD 126549

Unclassified

The relation between fine cyclic elements and proper cyclic elements are investigated by proving that a Peano space P of finite degree of multicoherence can be decomposed into a finite number of B-sets B_1, \dots, B_n such that (1) $B_i \cap B_j$ is either empty or else finite with $i \neq j$, (2) each fine cyclic element of P is a proper cyclic element of a unique B_i , and (3) each proper cyclic element of some B_i is a fine cyclic element of P .

PRF.01:011 - PRF.01:015

PRF.01:011

Purdue Research Foundation, Lafayette, Ind.

LEBESGUE AREA ZERO, DIMENSION, AND FINE CYCLIC ELEMENTS, by R. F. Williams. June 1957, 13p. (Technical note no. 10) (AFOSR-TN-57-422) (AF 18(600)1484) AD 136411 Unclassified

Surfaces are treated as maps f from general two-dimensional spaces X into a Euclidean space E . Three theorems are demonstrated which show that the surface has zero Lebesgue area only if it is essentially one-dimensional. It is stated as a corollary that Lebesgue area zero is a topological property. These theorems hold in quite general circumstances. Theorem 1 requires only that X be a bi-compact Hausdorff space, and theorems 2 and 3 require that X be a continuous curve of finite degree of multi-coherence. Theorem 3 characterizes Lebesgue area zero via fine cycle elements using results of Neugebauer, and generalizes a theorem of Radó.

PRF.01:012

Purdue Research Foundation, Lafayette, Ind.

THE DIRECT METHOD IN THE CALCULUS OF VARIATIONS, by L. H. Turner. Aug. 1957, 124p. incl. refs. (Technical note no. 11; rept. no. 1203) (AFOSR-TN-57-462) (AF 18(600)1484) AD 136453 Unclassified

In the present study, integrals on curves and surfaces are studied in relation to the direct method of the calculus of variations based on lower semicontinuity. An investigation is made in Chapter I of the convexity properties of integrand functions of the type used in the calculus of variations. In Chapter II, parametric curves and integrals on such curves are studied. Conditions for lower semicontinuity for integrals on curves are given in Chapter III. Chapter IV contains 3 existence theorems giving minima for nonparametric integrals. In Chapter V, parametric surfaces and corresponding integrals are studied. Sufficient conditions for lower semicontinuity are given for surface integrals in Chapter VI. These represent new proofs of theorems by L. Cesari. These proofs differ from his in that the proofs are given in terms of arbitrary representations and convexity conditions are substituted for conditions using differentiability of the integrand. (Contractor's abstract, modified)

PRF.01:013

Purdue Research Foundation, Lafayette, Ind.

ON THE COINCIDENCE OF GEÖCZE AND LEBESGUE

AREAS, by L. Cesari and C. J. Neugebauer. July 1957 [12]p. refs. (Technical note no. 12) (AFOSR-TN-57-463) (AF 18(600)1484) AD 136454 Unclassified

Also published in Duke Math. Jour., v. 26: 147-153, Mar. 1959.

Let (T,A) be a continuous mapping from an admissible set A of the Euclidean plane into Euclidean three-space (L. Cesari, Surface area, Princeton Univ., Princeton, N. J., 1956). Using their concepts of fine-cyclic elements (Cesari, Riv. Mat. Univ. Parma, v. 7: 149-185, 1956; Neugebauer, Trans. Amer. Math. Soc., v. 88: 121-136, 1958) and fine-cyclic additivity theorems, the authors give a new proof for the known result that the Lebesgue area and the Geöcze area of (T,A) are equal.

PRF.01:014

Purdue Research Foundation, Lafayette, Ind.

PRIME ENDS FOR OPEN SUBSETS OF TWO DIMENSIONAL MANIFOLDS I, by R. E. Fullerton. Aug. 1957, 23p. incl. diagrs. refs. (Technical note no. 13) (AFOSR-TN-57-590) (AF 18(600)1484) AD 136476 Unclassified

This investigation was carried out in order to obtain basic topological results necessary for the study of surfaces defined over two-manifolds. Considerable use is made of the theory of prime ends of plane domains in building up locally a prime end theory for open subsets of manifolds. Admissible ends and prime ends are defined and certain of their properties studied. It is shown that for simple Jordan regions these two concepts give equivalent results. It is expected that the data obtained from this study will be used in the future for the investigation of contours for surfaces defined on two-manifolds, and, in particular, for proving the Cesari-Cavalieri type inequality for such surfaces.

PRF.01:015

Purdue Research Foundation, Lafayette, Ind.

GENERALIZED LENGTH AND AN INEQUALITY OF CESARI FOR SURFACES DEFINED OVER TWO-MANIFOLDS, by R. E. Fullerton. Aug. 1957, 21p. (Technical note no. 14) (AFOSR-TN-57-591) (AF 18(600)1484) AD 136577 Unclassified

The theory of contours has been generalized so that the domain space of a mapping which defines a surface is a two-dimensional manifold rather than the restricted domain of the subsets of a plane. The prime end theory for open subsets of two-manifolds has made possible a treatment of mappings of open subsets on compact two-manifolds. The Cavalieri inequality of Cesari has been shown to be valid in this more general case and should be useful in developing theorems similar to those

PRF.01:016 - PRF.01:018

Involving mappings defined on planar sets. Let T be a mapping from a manifold M into E_n , let $[S]$ denote the set of points in E_n occupied by the surface S , let there be a real valued continuous function $f: [S] \rightarrow \text{Reals}$ defined on $[S]$, let t be a parameter $t_1 \leq t \leq t_2$ where $t_1 = f_{\max}$ and $t_2 = f_{\min}$, let σ be a segment of ends and prime ends of $A \subset S$, and let $\gamma\sigma$ be the set of points of the boundary γ which are end points of the ends and prime ends in σ . The following theorems have been proved: (1) $T(\gamma\sigma) \subset E_n$ is a continuous curve of length $\gamma\sigma$; (2) the generalized length $l(t)$ is lower semi-continuous in t , T and f ; (3) if $l(t) = 0$ for t outside the range of f , then $l(t) \leq \liminf_{\tau \rightarrow t} l(\tau)$ as $\tau \rightarrow t-0$ for all t , such that, $-\infty < t < \infty$; (4) let $\{T_n\}$ be a sequence of mappings from M into E_n with $\lim_{n \rightarrow \infty} T_n(p) = T(p)$ uniformly for $p \in M$; for all t such that, $-\infty < t < \infty$, then $l(t) \cdot \liminf_{\tau \rightarrow t} \inf_{n \rightarrow \infty} [l(t; T_n, M, f)]$; and (5) proof of the Cavalieri inequality of Cesari

$$K L(M, T) \geq \int_{-\infty}^{\infty} l(t) dt.$$

PRF.01:016

Purdue Research Foundation, Lafayette, Ind.

A NEW PROCESS OF RETRACTION AND THE DEFINITION OF FINE-CYCLIC ELEMENTS, by L. Cesari. [1957] [7]p. incl. refs. (AF 18(600)1484) Unclassified

Published in *Anal. Acad. Brasileira Ciencias*, v. 29: 1-7, Mar. 31, 1957.

It is the purpose of this paper to refer to a new concept of retraction for continuous mappings $S = (T, A)$ from a finitely connected Jordan region $A \subset J$ (mappings, or surfaces, of the type ν , where ν is the connectivity of J , $0 \leq \nu < +\infty$). New features have been observed for $\nu \geq 1$ which have no analogy in the case where J is a simple Jordan region ($\nu = 0$). It may for instance occur that a surface of type $\nu \geq 1$ presents a system of leaves linked together to form a unique cyclic element of a rather complex type, while each leaf may be of an extremely simple type, namely of the disc. To account for these simple elements of a surface, the new concept of fine-cyclic element σ of a mapping $S = (f, J)$ of the type ν has been introduced as a retraction of S , according to the new concept of retraction. The concept of fine-cyclic element has been discussed in great details. The fine-cyclic elements may be actually finer than the usual cyclic elements of the same mapping when $\nu \geq 1$, while they coincide with the usual cyclic elements when $\nu = 0$, i.e., when J is a simple closed Jordan region. The theory has been developed independently of the usual cyclic element theory, and is self-contained, based as it is on known properties of Elementary Topology of the Euclidean plane. The theory comprehends a fine-cyclic

additivity theorem for Lebesgue area, which is analogous to Morrey's and Radó's cyclic additivity theorem, and states that the Lebesgue area of a surface is equal to the countable sum of the areas of its fine-cyclic elements. Also, the fine-cyclic elements are characterized as retractions of a given surface, having particular maximal-minimal properties. (Contractor's abstract)

PRF.01:017

Purdue Research Foundation, Lafayette, Ind.

SMOOTHING METHODS FOR CONTOURS, by L. Cesari and R. E. Fullerton. [1957] [11]p. (AF 18(600)1484) Unclassified

Published in *Illinois Jour. Math.*, v. 1: 395-405, Sept. 1957.

In connection with his work on Cavalieri's inequality and its applications, Cesari devised a first smoothing method for contours [Rend. Matem. e Appl., v. 15: 341-365, 1956], roughly as follows: Given a map T from the closure of a simply-connected plane domain A , the sum of the continua of constancy of T which meet a set E constitute the corresponding "shaggy set" E''' ; further, by the join of two sets in a continuum K , i.e., an irreducible subcontinuum which meets both; and the shaggy set which corresponds to this join may be termed shaggy join. This being so, let C be a portion of the boundary of A determined by an interval of prime ends $< 2\pi$ between two distinct prime ends ω_1, ω_2 , and let E''' be a shaggy join of ω_1, ω_2 in C''' . Then the first smoothing operation consists in replacing C by a corresponding portion of the boundary of the set $A - E'''$. A second and a third smoothing process are now considered, the former of which turns out to be fully equivalent to the first, and the latter partially so. (Math. Rev. abstract)

PRF.01:018

Purdue Research Foundation, Lafayette, Ind.

ON SOME THEOREMS CONCERNING THE EQUALITY OF LEBESGUE AND PEANO AREAS, by L. Cesari and T. Nishtura. Feb. 1958, 23p. (Technical note no. 15) (AFOSR-TN-58-329) (AF 18(600)1484) AD 154233; PB 135977 Unclassified

Theorems concerning continuous mappings (T, A) of finite Geöcze area $V(A, T) < +\infty$ from an admissible set $A \subset E_2$ into E_3 are studied. Theorem 1 and the more detailed theorem III state that given any positive number ϵ , there exists an appropriate finite collection $\{\pi\}$ of non-overlapping simple polygonal regions $\pi \subset A$ and a corresponding collection $\{\tau\}$ of projection maps $\tau: E_3 - E_2' \subset E_3$ from the three-dimensional space E_3 onto two-dimensional spaces E_2' (one for every π) such that

PRF.01:019 - PRF.01:022

$V(A, T) - \sum V(\pi, \tau, T) < \epsilon$, where \sum ranges over all $\pi \in [\pi]$. Theorem IV of the present paper allows the replacement of the above inequality of theorem I with $V(A, T) - \sum V(\pi, \tau T) < \epsilon$. It is proved that analogous relations subsist between theorem III and theorem V. With either theorem III or V one can prove theorem II which implies the basic equality $L = V = P$. Theorem II states that there is another continuous mapping (T^*, A) with $V(A, T^*) < +\infty$ such that $d(T, T^*, A) < \epsilon$, T^* maps a finite collection $[q]$ of disjoint squares $q \subset A$ onto squares $Q \in E_3$, and $V(A, T) + \epsilon > V(A, T^*) \sum |Q| > V(A, T) - \epsilon$, where \sum ranges over all $q \in [q]$.

PRF.01:019

Purdue Research Foundation, Lafayette, Ind.

ON THE CONCEPT OF SURFACE INTEGRAL, by L. Cesari and L. H. Turner. [1958] [2]p. [AF 18(600)1484] Unclassified

Published in Proc. Nat'l. Acad. Sciences, v. 44: 42-43, Jan. 1958.

By a surface $S = (T, A)$ is meant a continuous mapping T from an admissible set A of E_2 into E_3 . Cesari [Ann. Scuola Norm. Sup. Pisa, v. 13: 77-117, 1944] has defined the surface integral

$$J(T, A, f) = \int_A f(p, t),$$

for any surface of finite area and for any f on $T(A) \times S^2$ to the reals, which is uniformly continuous, S^2 being the unit sphere $t_1^2 + t_2^2 + t_3^2 = 1$ in E_3 . Here $p = T(w)$ for $w \in A$. This definition has since been fundamental for problems of the calculus of variations for parametric surfaces. It generalized, for example, the Tonelli integral

$$I(T, A, f) = \int_A f(T(w), J(w))dw,$$

where $J(w)$ is the generalized Jacobian at w , to the general situation in which the latter does not exist. In the present paper the authors construct, from the Cesari variation functions, a measure ν and new set functions V_1, V_2, V_3 . The Radon-Nikodym derivatives $\theta_r = dV_r/d\nu$ exist always, and $\theta_1^2 + \theta_2^2 + \theta_3^2 = 1$ almost everywhere. The integral

$$H(T, A, f) = \int_A f(T(w), \theta(w))d\nu,$$

where $\theta(w) = (\theta_1(w), \theta_2(w), \theta_3(w))$, then exists for every surface of finite area and every f bounded and B-measurable in $T(A) \times S^2$. The principal theorem is that then $J(T, A, f) = H(T, A, f)$. H thus gives a definition of surface area and an integral representation of J valid for every surface of finite area. (Math. Rev. abstract)

PRF.01:020

Purdue [Research Foundation] Lafayette, Ind.

VARIATION, MULTIPLICITY, AND SEMICONTINUITY, by L. Cesari. [1958] [16]p. incl. diagrs. [AF 18(600)1484] Unclassified

Published in Amer. Math. Monthly, v. 65: 317-332, May 1958.

In this paper, the following aspects of the concept of total variation are discussed: (1) Jordan total variation; (2) The Jordan total variation as a limit; (3) The multiplicity function; (4) The Jordan total variation as a Jordan length; (5) Positive and negative total variations; (6) The functions $\nu(u), \nu_+(u), \nu_-(u)$; (7) Lower semicontinuity of the total variation; (8) On maxima and minima of continuous functions; (9) The multiplicity functions N_c, N_+, N_- and their properties of lower semicontinuity; (10) A necessary and sufficient condition for absolute continuity; and (11) The theorem of Lebesgue and its corollaries.

PRF.01:021

[Purdue Research Foundation, Lafayette, Ind.].

SURFACE INTEGRAL AND RADON-NIKODYM DERIVATIVES, by L. Cesari and L. H. Turner. [1958] [12]p. (AF 18(600)1484) Unclassified

Published in Rend. Circ. Matem. Palermo, Series II, v. 7: 143-154, May-Aug. 1958.

(T, A) is considered to be ac.BV mapping (a continuous surface of finite area) from an admissible set $A \subset E_2$ into E_3 : $p = T(w)$, $w = (u, v) \in A$, $p = (x, y, z) \in E_3$. \mathcal{B} is taken as a finite set of nonoverlapping simple polygonal regions $\sigma \subset A$ and σ^* is the oriented boundary of σ . A mapping T_σ maps σ^* onto a closed oriented curve C_{σ^*} in E_{2r} . The topological index $O(p; C_{\sigma^*})$ of points of C_{σ^*} is Borel measurable and integrable over E_{2r} . A set \mathcal{B} is defined by indices d, m, μ and such that $d = \max \{ \text{diam } T(\sigma) : \sigma \in \mathcal{B} \}$, $m = \max \{ |T_\sigma(\mathcal{L}\sigma^*)| : \sigma \in \mathcal{B} \}$, $\mu = \max \{ |V(T, A) - \sum u(\sigma, T), V(T_\sigma, A) - \sum u(\sigma, T_\sigma)| : \sigma \in \mathcal{B} \}$, where the absolute value sign denotes 2 dimensional Lebesgue measure, and the sum ranges over all $\sigma \in \mathcal{B}$ and $\mu = \max \{ |V(T, A) - \sum u(\sigma, T), V(T_\sigma, A) - \sum u(\sigma, T_\sigma)| : \sigma \in \mathcal{B} \}$, where $V(T, A)$ is the Geöcze area of (T, A) , and $V(T_\sigma, A)$ the Geöcze area of (T_σ, A) .

PRF.01:022

Purdue [Research Foundation] Lafayette, Ind.

RECTIFIABLE CURVES AND THE WEIERSTRASS

PRF.01:023; PRF.03:001; PRF.02:004

INTEGRAL, by L. Cesari. [1958] [16]p. incl. diagrs.
(AF 18(600)1484) Unclassified

Published in Amer. Math. Monthly, v. 65: 485-500,
Aug.-Sept. 1958.

This brief exposition intends to emphasize those parts of the theory for rectifiable curves which are of greater interest because of their recent extensions to surfaces. Those areas of interest presented in this report are parametric curves, the Jordan length, the Jordan theorem, lower semicontinuity of the Jordan length, the function $s(u)$, the Tonelli theorems, the Noebeling theorem, Lebesgue and Fréchet equivalences, Fréchet distances of two curves, the representation theorem, and the line integral as a Weierstrass integral.

is analyzed is a single-stage device which uses a simple RC differentiating network, followed by an infinite clipper and a simple RC smoothing filter. Negative feedback is used around the clipper and smoothing filter to insure that the filter output is always directly proportional to the derivative of the input signal. The noise reduction obtained from such a device is found to be rather poor compared with linear filters. Next, an analysis is made of a 2-stage nonlinear filter made up of a simple RC differentiating network followed, successively, by an idealized dead-zone symmetrical clipper, a lead network, and a simple RC smoothing filter. This filter uses the same type of feedback that was used in the single-stage case. The two-stage nonlinear filter is capable of a great amount of noise reduction and a small settling time, especially if the input S/N ratio is small. (ASTIA abstract)

PRF.01:023

Purdue Research Foundation, Lafayette, Ind.

AN INVARIANT PROPERTY OF CESARI'S SURFACE INTEGRAL, by L. H. Turner. [1958] [6]p. (AF 18-
(600)1484) Unclassified

Published in Proc. Amer. Math. Soc., v. 9: 920-925,
Dec. 1958.

The author gives a modified definition for Cesari's surface integral and shows that it is equivalent to the original one [L. Cesari, Surface area, Princeton Univ. Press, Princeton, N. J., 1956]. The new definition is in terms of the vector-valued set-function $\gamma = (\gamma_1, \gamma_2, \gamma_3)$, where $\gamma_r = V_r^+ - V_r^-$, V_r^+ and V_r^- being defined, as by Cesari [loc. cit.], as the signed variations of partial plane transformations, $r = 1, 2, 3$. Then the coordinates of γ change covariantly under rotations of 3-space, from which Cesari's surface integral is invariant under such rotations. (Math. Rev. abstract)

PRF.02:004

Purdue Research Foundation, Lafayette, Ind.

ON SEMI-NORMAL OPERATORS, by C. R. Putnam.
July 1957, 5p. (Technical note no. 3) (AFOSR-TN-57-89)
(AF 18(603)139) AD 120437 Unclassified

Also published in Pacific Jour. Math., v. 7: 1649-1652,
1957.

Investigation is made of the spectrum of seminormal operators and of the associated self-adjoint operators defined by $J_\theta = \frac{1}{2}(A_\theta + A_\theta^*)$, where $A_\theta = Ae^{-i\theta}$ and θ is real. A is a seminormal bounded linear operator in a Hilbert space H . J_θ becomes the real or the imaginary part of A as $\theta = 0 = \pi/2$. A number λ belonging to the spectrum of A $sp(A)$ is accessible if there exists a sequence of numbers λ_n not belonging to $sp(A)$ for which $\lambda_n \rightarrow \lambda$ as $n \rightarrow \infty$. If M is any self-adjoint operator, $\max M$ and $\min M$ denote the greatest and the least points, respectively, of the set $sp(M)$. The following theorems are proved: (1) Let A be semi-normal with $H \geq 0$ and $\lambda = re^{i\theta}$ (r is real and ≥ 0) be an accessible point of the spectrum of A ; then
 $(\max J_\theta)^2 \geq \min AA^*$ and $|r - \max J_\theta| \leq ((\max J_\theta)^2 - \min AA^*)^{1/2}$ where J_θ is defined as above.
(2) Let A be seminormal and let $J = J_\theta$ have the spectral resolution $J = \int \lambda dE$; then if $S = S_\theta$ is any measurable set for which $\int_S dE = I$, the inequality $\|H\| \leq 4 \|A\|$ meas S holds. (See also Technical note no. 1, PRF.02:001; Technical note no. 2, PRF.02:002)

PRF.03:001

Purdue Research Foundation, Lafayette, Ind.

NONLINEAR DIFFERENTIATING FILTERS, by G. R. Cooper and J. E. Kemmerly. Final technical rept.
Feb. 1, 1956-May 5, 1958, 78p. incl. diagrs. tables, refs.
(AFOSR-TR-58-56) (AF 18(600)1588) AD 162106
Unclassified

Two nonlinear filters, using negative feedback are considered. The filters incorporate a so-called infinite clipper and an idealized symmetrical clipper containing a dead zone. The statistical properties of the outputs of these 2 nonlinearities are then described, and it is shown that the mean value of the output can be made directly proportional to the mean value of the input under certain conditions. The autocorrelation functions of the outputs are also derived. The first nonlinear filter which

PRF.02:005 - PRF.02:009

PRF.02:005

Purdue Research Foundation, Lafayette, Ind.

COMMUTATORS ON A HILBERT SPACE, by C. R. Putnam. Sept. 1957, 2p. (AFOSR-TR-57-87) (AF 18-803)139) Unclassified

A brief summary is given of the research carried out under the contract for the period Sept. 1, 1958 through Aug. 31, 1957.

PRF.02:006

Purdue Research Foundation, Lafayette, Ind.

ON THE NUMERICAL RANGES OF COMMUTATORS, by C. R. Putnam. May 1958, 8p. (Technical note no. 5) (AFOSR-TN-58-115) (AF 18(803)139) AD 182130; PB 135085 Unclassified

Also published in Jour. London Math. Soc., v. 34: 23-28, Jan. 1959.

A few facts are collected concerning the numerical ranges W_C of commutators $C = AB - BA$, where A and B are bounded linear operators on a Hilbert space of elements x . W_C is defined as the (closed, convex) set consisting of the closure of the set of complex numbers (Cx, x) where $\|x\| = 1$. A complex number z will be said to be in the interior of W_C if one of the following holds: (1) W_C consists of z alone, (2) W_C is an interval and z is an interior point, or (3) W_C is two-dimensional and z is an interior point. If z belongs to W_C but is not an interior point, z will be called a boundary point of W_C .

PRF.02:007

Purdue Research Foundation, Lafayette, Ind.

COMMUTATORS AND NORMAL OPERATORS, by C. R. Putnam. May 1958, 4p. (Technical note no. 8) (AFOSR-TN-58-116) (AF 18(803)139) AD 152024 Unclassified

Also published in Portugal. Math., v. 17: 59-62, 1956

The following theorems are proved: (1) Let A be normal with the Cartesian representation $A = H + iJ$, $H = \frac{1}{2}(A + A^*)$ and $J = \frac{1}{2i}(A - A^*)$; let B be arbitrary, and let $C = AB - BA$. Then 0 is in the interior of the convex closed set W_C (consisting of the closure of the set of numbers (Cx, x) when $\|x\| = 1$), whenever $\liminf_{\delta \rightarrow 0} \dots$

$[f(H, \delta) f(J, \delta)/\delta] = 0$. (2) If A satisfying $\liminf_{\delta \rightarrow 0} \dots$

$[f(H, \delta) f(J, \delta)/\delta] = 0$ is normal and if $\text{meas}(\text{sp}(H)) = 0$ and J has a pure point spectrum, then 0 is in the interior of W_C . The notation is as follows: A and B are bounded linear operators on a Hilbert space of elements x . Let D be self-adjoint and let $\{A_k\}$ denote any covering of $\text{sp}(D)$, the spectrum of D , by a finite number of intervals A_k of length d_k . For $\delta > 0$, the positive numbers $f(D, \delta)$ and $g(D, \delta)$ are defined by $f(D, \delta) = \inf(\sum_k d_k)$, where $d_k \geq \delta$, and $g(D, \delta) = \inf(\sum_k d_k)$, where $d_k = \delta$.

PRF.02:008

Purdue Research Foundation, Lafayette, Ind.

ON BOUNDED MATRICES WITH NON-NEGATIVE ELEMENTS, by C. R. Putnam. May 1958, 7p. incl. refs. (Technical note no. 7) (AFOSR-TN-58-199) (AF 18(803)139) AD 152232 Unclassified

Also published in Canad. Jour. Math., v. 10: 587-591, 1958.

Analogous to the Rutman-Krein (Amer. Math. Soc. Translation no. 26) results for completely continuous operators are given for operators which are not necessarily completely continuous. The context is that of a Hilbert space of real vectors and bounded operators represented by real matrices.

PRF.02:009

Purdue Research Foundation, Lafayette, Ind.

ON SQUARE ROOTS AND LOGARITHMS OF SELF-ADJOINT OPERATORS, by C. R. Putnam. May 1958, 8p. (Technical rept. no. 4) (AFOSR-TN-58-275) (AF 18(803)139) AD 154177 Unclassified

Also published in Proc. Glasgow Math. Assoc., v. 4: 1-7, 1958.

The following theorems are proved: (1) If B is a non-negative self-adjoint operator, and if A is any solution of $A^2 = B$ (A is not assumed to be self-adjoint or even normal) satisfying $\text{Re}(A) < 0$, then necessarily A is the unique non-negative self-adjoint square root of B . (2) If A is a logarithm of a positive self-adjoint operator $B = \int \lambda dE$ so that $e^A = B$ (> 0) and if $A < 2 \log 2$ then necessarily A is the self-adjoint operator $A = \int \log \lambda dE$ ($\log \lambda$ real). All operators are bounded and linear on a Hilbert space.

PRF.02:010; PUR.07:001-004

PRF.02:010

Purdue Research Foundation, Lafayette, Ind.

ON TOEPLITZ MATRICES, ABSOLUTE CONTINUITY, AND UNITARY EQUIVALENCE, by C. R. Putnam. May 1959, 13p. incl. refs. (Technical note no. 8) (AFOSR-TN-58-618) (AF 18(603)139) AD 162147; PB 142617 Unclassified

Also published in Pacific Jour. Math., v. 9: 837-846, 1959.

Let $\{c_n\}$, where $n = 0, \pm 1, \pm 2, \dots$, be real numbers satisfying $c_0 = 0$, $c_{-n} = c_n$ and $\sum_{n=1}^{\infty} c_n^2 < \infty$ and consider the associated real-valued even function $f(\theta)$ of period 2π and of class $L^2[0, \pi]$ defined by

$$f(\theta) \sim \sum_{n=-\infty}^{+\infty} c_n e^{in\theta} = 2 \sum_{n=1}^{\infty} c_n \cos n\theta. \text{ The matrices}$$

$T = (c_{j-k})$ and $K = (c_{j+k})$ are called Toeplitz and Hankel matrices, respectively. Various consequences of the

2 relations $T = F + K$, where $F = (\int_0^\pi f(\theta) d\rho_{jj}(\theta))$, and $d\rho_{jj}(\theta)$ is the differential of the spectral matrix belonging to the quadratic form $2\sum_{j=1}^{\infty} x_{j+1}$, are obtained. The unbounded matrix (b_{jj}) is shown to be self-adjoint and absolutely continuous. This matrix is related to the bounded Hilbert matrices, $S = (1/(i-j))$ and $H = (1/(i-j-1))$.

Purdue U. Lafayette, Ind.
N6ori-10503, Project SQUID see under
Princeton U. James Forrestal Research Center, N. J.
(Project SQUID) item no. no. PRL11:215

PUR.07:001

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE STOICHIOMETRY, RESISTIVITY, AND THERMOELECTRIC POWER OF CERIUM DIOXIDE BELOW 500°C, by A. W. Czanderna and J. M. Honig. Sept. 1957 [31]p. incl. diagrs. table, refs. (AFOSR-TN-57-602) (AF 18(603)45) AD 136591 Unclassified

Resistivity, thermoelectric power, and mass change measurements were carried out on column purified CeO_2 . It was concluded that CeO_2 suffers a loss of oxygen reversibly from surface regions in the temperature range 160° to 485°C. Incipient bulk decomposition appears to set in above 600°C.

PUR.07:002

Purdue U. Dept. of Chemistry, Lafayette, Ind.

LITERATURE REVIEW ON PROPERTIES OF PRASEODYMIUM AND CERIUM OXIDES, by J. M. Honig. Jan. 1958, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-57) (AF 18(603)45) AD 148098 Unclassified

The physical properties of Ce and Pr oxides are discussed; comments are made on some characteristics of the rare earth series. The discussions are organized under the following headings: (1) the stoichiometry of pure Pr oxide and its interaction with oxidizing and reducing gases; (2) the crystal structure of Pr oxides; (3) the stoichiometry of Ce oxides; (4) the crystal structure of Ce oxides; (5) properties of Pr and Ce oxides in the presence of foreign ions; and (6) miscellaneous. (Contractor's abstract)

PUR.07:003

Purdue U. Dept. of Chemistry, Lafayette, Ind.

STRESS RELAXATION AND EXCHANGE IN PELLETS USED FOR THE INFRA-RED TECHNIQUES, by F. Vrátný. Aug. 1958 [10]p. incl. diagrs. (AFOSR-TN-58-867) (AF 18(603)45) AD 203668 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 10: 328-332, May 1959.

In the pelleting of lead nitrates for infra-red study, exchange between lead nitrates and potassium chloride proceeds at a logarithmic rate. Water adsorption and stress relaxation also proceed at logarithmic rates. Increasing the rate of water adsorption enhances the rate of exchange and stress relaxation. (Contractor's abstract)

PUR.07:004

Purdue U. Dept. of Chemistry, Lafayette, Ind.

INFRARED SPECTRA OF METAL NITRATES, by F. Vrátný. Aug. 1958 [21]p. incl. diagrs. tables. (AFOSR-TN-58-868) (AF 18(603)45) AD 203667 Unclassified

The spectra of 35 metal nitrates were studied in the 2-15 μ region. The observed frequencies were tabulated and an interpretation of the spectra made on the basis of varying symmetry types. A correlation is made between a decrease in the magnitude of the γ , frequency (1050 cm^{-1}) of the D_{3h} symmetric nitrate ion and the increase in the covalent bonding character. (Contractor's abstract)

PUR.07:005, 006; PUR.08:001, 002

PUR.07:005

Purdue U. Dept. of Chemistry, Lafayette, Ind.

AN ANNULAR JET PUMP, by W. H. Haak and F. Vrátný. Oct. 1958, 2p. diagr. (AFOSR-TN-58-937) (AF 18(603)-45) AD 205089; PB 137842 Unclassified

Also published in Rev. Scient. Instruments, v. 30: 296-297, Apr. 1959.

The need for a fast pump, capable of attaining a high ultimate vacuum and functioning over extended periods of time, led to the design of a two stage annular jet pump. Tests of the design demonstrated two advantages over the design suggested by Bull: (1) the extent of mercury diffusion was significantly reduced, and (2) the consumption of liquid nitrogen was likewise appreciably diminished. The annular spacing between the concentric cones and the distance between the bottom of the first and second stage jets are considered critical dimensions in the construction of the pump.

PUR.07:006

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE COMPOSITION, RESISTIVITY, AND THERMOELECTRIC POWER OF CERIUM OXIDES BELOW 500°C, by A. W. Czanderna and J. M. Honig. [1958] [2]p. incl. diagrs. (AF 18(603)45) Unclassified

Published in Jour. Phys. Chem. Solids, v. 6: 96-97, July 1958.

Res thermoelectric power, and mass change measurements on column purified CeO_2 were carried out. It is deduced that in the range 160-485°C, CeO_2 loses O reversibly from surface regions. Incipient bulk decomposition appears to set in above 600°C.

PUR.08:001

Purdue U. [Dept. of Chemistry] Lafayette, Ind.

SEPARATION OF METAL IONS UTILIZING 1,10-PHENANTHROLINE COORDINATION KINETICS (Abstract), by D. W. Margerum and J. O. Frohner. [1957] [2]p. [AF 49(638)60] Unclassified

Presented at meeting of the Analyt. Chem. Div. of the Amer. Chem. Soc., New York, Sept. 8-13 1957

Published in 132nd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 24-B-30-8.

Coordination kinetics presents a new approach to obtaining metal ions in separable forms. By utilizing differences in coordination rates, it is possible to place

metal ions in significantly different chemical states and separate them from one another before the system reaches equilibrium. Hence a new variable - the coordination rate - can be used for possible separations in addition to the usual variables such as solubility, equilibrium state, oxidation potential, etc. This paper illustrates how separations can be achieved using 1,10-phenanthroline as the coordinating group. Various metal ions of the transition group elements have markedly different reaction rates in chelation with 1,10-phenanthroline. Advantage is taken of differences in rates of formation and of dissociation of these complexes to form separable species. It is possible to have in solution for short periods of time two metal ions bonded to dissimilar coordination groups, even though at equilibrium both metal ions are similarly complexed. For example, the phenanthroline complexes of nickel(II) and the aquo complex of copper(II) can be made to exist in solution simultaneously for an appreciable time interval. The coordination rate can lead not only to such differences as these (one metal ion bonded to large organic molecules and the other bonded to small water molecules) but also to changes in the charge of the complex. For example, the positive iron(II)-phenanthroline complex and the negative copper(II)-EDTA complex can exist simultaneously. Once such temporary differences in the coordination of the metal ions have been achieved, the problem becomes rapid separation by taking advantage of the marked differences in chemical and physical properties of the complexes. The separations discussed are achieved by extraction and fast flow adsorption and ion-exchange columns. The use of silica gel, charcoal and Dowex 50 columns is discussed. Separations involving the phenanthroline complexes of vanadium, chromium, iron, cobalt, nickel, copper, and zinc are presented.

PUR.08:002

Purdue U. Dept. of Chemistry, Lafayette, Ind.

COORDINATION KINETICS OF ETHYLENEDIAMINETETRAACETATE COMPLEXES, by D. W. Margerum. [1958] [17]p. incl. diagrs. table, refs. (AFOSR-TN-58-844) [AF 49(638)60] AD 203334 Unclassified

Also published in Jour. Phys. Chem., v. 63: 336-339, Mar. 1959.

Kinetic studies indicate several intermediate EDTA complexes, some with decreased degree of coordination of the ligand to its central ion and others with more than one metal ion per ligand. A number of these intermediate complexes are observed in solution with ultraviolet spectrophotometry. The inertness of the EDTA exchange reactions parallels the stability of the complexes. Exchange reactions proceed by S_N2 and S_N1 paths and both are subject to acid catalysis. (Contractor's abstract)

PUR. 08:003; PUR. 09:001;
PUR. 10:001, 002

PUR.08:003

Purdue U. [Dept. of Chemistry] Lafayette, Ind.

COORDINATION KINETICS OF THE EDTA-NICKEL(II) COMPLEX (Abstract), by W. Margerum and J. F. G. Clarke, Jr. [1958] [1]p. [AF 49(638)60] Unclassified

Presented at meeting of the Phys. and Inorg. Chem. Div. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Published in 133rd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 48-Q.

Special injection and spectrophotometric recording techniques were used to follow the dissociation rate of the nickel(II) ethylenediaminetetraacetic acid complex, NiY^{4-} . The reactions were followed after a 5 to 15-sec mixing time of the complex with acid. At the highest acidity used, 0.70M hydrochloric acid, the dissociation was virtually complete after 30 sec. The dissociation rate increases greatly with acidity. A 20-fold increase in acidity (0.035 to 0.700M hydrochloric acid) causes a 500-fold increase in dissociation rate. All kinetics were measured at 25° and at an ionic strength of 1.3. Spectrophotometric evidence confirms the formation of a protonated complex above 0.01M acid, presumably NiHY^{3-} . Above 1M hydrochloric acid additional shifts in absorbance suggest the existence of another complex, perhaps NiH_2Y . The high dependence of the dissociation rate on $[\text{H}^+]$ indicates a more rapid dissociation of the protonated forms of the complex. The hydrogen ion dependence is higher than first order. A thousandfold excess of zinc(II) at 0.035M hydrochloric acid does not increase the dissociation rate.

PUR.09:001

Purdue U. Dept. of Chemistry, Lafayette, Ind.

HETEROGENEITY AS A FACTOR IN THE ALKYLATION OF AMBIDENT ANIONS: PHENOXIDE IONS, by N. Kornblum and A. P. Lurie. [1958] [43]p. incl. diagrs. tables, refs. (AFOSR-TN-58-939) (AF 49(638)324) AD 205087 Unclassified

Presented at meeting of the Inorg. Chem. Div. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Abstract published in 133rd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 14-N-15-N.

Also published in Jour. Amer. Chem. Soc., v. 81: 2705-2715, June 5, 1959.

Sodium and potassium salts of phenol and p-tert-octylphenol have been alkylated with benzyl and allyl halides in a variety of solvents. Quantitative yields of the ether (oxygen alkylation) are obtained whenever the

reaction is conducted in solution. In addition, it is demonstrated that the truly heterogeneous reaction gives exclusively carbon alkylation. Reactions carried out with the phenolic salt present as a solid phase ordinarily give both carbon and oxygen alkylation, but this result is clearly a consequence of incursion by the homogeneous process. The factors, other than heterogeneity, which may influence the course of phenoxide alkylations are briefly discussed. An explanation is offered for the fact that heterogeneity confers an essentially irresistible preference for carbon alkylation. (Contractor's abstract)

PUR.10:001

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

ASYMPTOTIC SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS, by N. D. Kazarinoff. Summary technical rept. Sept. 1957 [4]p. (AFOSR-TN-57-494) (AF 18-(600)1481) AD 136484 Unclassified

A summary is presented of the research done on the subject. The papers prepared are listed and the results are reviewed of work on the Whittaker equation and differential equations with 2 turning points, and differential equations which have regular singular points and a large parameter.

PUR.10:002

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

ASYMPTOTIC FORMS FOR THE WHITTAKER FUNCTIONS WITH BOTH PARAMETERS LARGE, by N. D. Kazarinoff. 1957 [20]p. incl. diagrs. refs. (AFOSR-TN-58-576) (AF 18(600)1481) AD 142763 Unclassified

Also published in Jour. Math. and Mech., v. 6: 341-360, May 1957.

Certain solutions of the differential equation

$$\frac{d^2 w}{dx^2} + \left\{ -1/4 + k/x + \frac{1/4 - m^2}{x^2} \right\} w = 0$$

are called Whittaker functions and are customarily designated $W_{k,m}(x)$ and $M_{k,m}(x)$. Their asymptotic behavior is different accordingly as 1, 2, or 3 of the quantities $|x|$, $|k|$, and $|m|$ are large. An examination of the literature reveals that least is known of the structure of the Whittaker functions if both k and m are unbounded. When $|x|$ is also large, such information as is available applies only to nearly real values of x and k and nearly real or pure imaginary values of m and is subject to the further limitation that the ratios x/k and x/m be nearly fixed. In this study, the asymptotic behavior of the Whittaker functions with x , k , and m real or complex is obtained for both $|k|$ and $|m|$ large and x unrestricted

PUR. 10:003; PUR. 02:002-004

under the hypothesis that $(m^2 - k^2)/k$ be bounded, so that $\lim m/k = \pm 1$. The results are stated in theorems. $|k| \rightarrow \infty$

The analysis to be given is based upon the methods of asymptotic solution of ordinary differential equations containing a large parameter developed by R. E. Langer. In the present study, particular reference is made to the work of R. McKelvey. (Trans. Amer. Math. Soc., v. 67: 461-490, 1959).

PUR. 10:003

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

ASYMPTOTIC SOLUTIONS WITH RESPECT TO A PARAMETER OF ORDINARY DIFFERENTIAL EQUATIONS HAVING A REGULAR SINGULAR POINT, by N. D. Kazarinoff. [1957] [14]p. (AFOSR-TN-58-577) (AF 18(600)1481) AD 158399 Unclassified

Also published in Mich. Math. Jour., v. 4: 207-220, 1957.

The asymptotic behavior is examined for large complex λ of solutions of the differential equation

$$\frac{d^2 u}{dz^2} + \sum_{i=1}^n f_i(z) \lambda^{-i} u = 0$$

where the sum is assumed convergent for $|\lambda| > N$, and $f_{-2}(z)$, $z f_{-1}(z)$, $z^2 f_1(z)$ ($i = 0, 1, 2, \dots$) are analytic in a closed simply-connected region D containing the origin in its interior. The investigation generally follows the pattern established by R. E. Langer. The asymptotic forms of the solutions are expressed in terms of Bessel functions when $\xi = \lambda \int_0^z [f_{-2}(t)]^{1/2} dt$ is bounded, and in terms of elementary functions when ξ is large. The work is motivated partly by its potential applications to special functions, and partly by a desire to progress towards completion of the asymptotic theory of differential equations with turning points. (Math. Rev. abstract)

PUR. 02:002

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

SPECTRA OF CONVOLUTION OPERATIONS ON L^p AND RINGS OF FACTOR-SEQUENCES, by G. L. Krabbe. June 9, 1956, 12p. incl. refs. (AFOSR-TN-57-12) (AF 18(603)44) AD 115044 Unclassified

Also published in Quart. Jour. Math., v. 8: 1-12, Mar. 1957.

This paper considers the spaces of bounded sequences

$c = \{c_n\} = \langle c_n \rangle$, such that

$$\text{l.u.b.} \sum_N |c_{n+1} - c_n| = M < \infty,$$

where \sum_N is extended over $2^N \leq |n| \leq 2^{N+1}$, $N = 0, 1, 2, \dots$, and introduces the norm $\|c\| = \|c_n\|_\infty + M$. According to a theorem of Marcinkiewicz (Studia Math., v. 8: 78-91, 1939) if a_n are the Fourier coefficients of a function f in L^p , $1 < p < \infty$, then the a_n are the Fourier coefficients of a function Tf in L^p . The author proves that $\bar{\omega}(c) = \sigma(T) = \sigma(c)$, where $\bar{\omega}(c)$ is the closure of the set $\{c_n\}$, $\sigma(T)$ and $\sigma(c)$ are the spectra of T and c respectively. He further shows that $\|c\|_\infty \leq \|T\|_p \leq k_p \|c\|$. (Math. Rev. abstract)

PUR. 02:003

Purdue U. Dept. of Mathematics, Lafayette, Ind.

SPECTRAL INVARIANCE OF CONVOLUTION OPERATORS ON L^p ($-\infty, \infty$), by G. L. Krabbe. May 9, 1957, 18p. incl. refs. (Technical note no. 2) (AFOSR-TN-57-238) (AF 18(603)44) AD 126535 Unclassified

Also published in Duks Math. Jour., v. 25: 131-142, Mar. 1958.

For a given bounded Radon measure A on $G = (-\infty, \infty)$, convolution operators $A * f$ defined by the integral $\int_G f(\theta - \alpha) dA(\alpha)$ are studied as mappings from L_p into L_p . It is shown under certain restrictions on A that the spectrum of the convolution is independent of p and is the same as the spectrum of A , which is the closure of the range of the Fourier transform of A . An appendix contains the referee's proof that this result is true if G is an arbitrary locally compact Abelian group and A is a bounded Radon measure on $L^p(G)$. Among others, results are obtained concerning the point spectrum which generalize those proved by H. Pollard in the case $p = 2$. (Math. Rev. abstract)

PUR. 02:004

Purdue U. Dept. of Mathematics, Lafayette, Ind.

VAGUELY NORMAL OPERATORS ON A BANACH SPACE, by G. L. Krabbe. Mar. 5, 1958, 15p. incl. refs. (Technical note no. 3) (AFOSR-TN-58-183) (AF 18(603)44) AD 152190; PB 140156 Unclassified

Also published in Arch. Rational Mech. Anal., v. 3: 51-59, 1958.

Properties of normal (Hilbert space) operators are

PUR.02:005, 006; PUR.11:001

extended to Banach space operators. If β is the Haar measure of a locally compact abelian group G , then the relation $(x|y) = \int_G x(\lambda) \cdot y(\lambda) \cdot \beta(d\lambda)$ for all (x, y) in $L^p(G) \times L^{p'}(G)$ defines the inner product in the space $L^2(G)$ when $p = 2$. If $R[L^p(G)]$ is the set of all operators T on $L^p(G) \cup L^{p'}(G)$ such that $(Tx|y) = (x|Ty)$ for all (x, y) , then $N[L^p(G)]$ denotes the set of all operators of the form $T_1 + iT_2$, where T_1 and T_2 are in $R[L^p(G)]$. An operator is called vaguely normal if it is a bounded operator on $L^p(G)$ that has an extension in $N[L^p(G)]$; $G = \{0, \pm 1, \pm 2, \dots\}$. Consider a certain algebra A_{*p} of convolution operators on $l_p = L^p(G)$. A_{*p} consists of vaguely normal operators and is included in the weak closure of the algebra generated by the Hilbert transformation $x \rightarrow Hx$, for a suitably defined Hx . To each T in A_{*p} there corresponds an operator-valued measure E^T and a function f such that the relation $T = \int \lambda E^T(d\lambda)$ holds in a certain sense. When $p = 2$, $T = f(H)$. If $p \geq 2$, then the resolvent set of T is void and thereby extends another property of normal operators.

SPECTRAL THEOREM, by G. L. Krabbe. May 15, 1958, 28p. incl. refs. (Technical note no. 6) (AFOSR-TR-58-65) (AF 18(603)44) AD 158260; PB 139564
Unclassified

Also published in Math. Zeitschr. v. 70: 446-462, Mar. 1959.

Let $[X]$ be the Banach algebra of all bounded operators on a Banach space X . Sufficient conditions are given for which the following occur: (1) T belongs to the class of C_0 of all members T of $[X]$ which have a pass E_Δ^T such that $K(E_\Delta^T)$ is included in the point-spectrum of T ; (2) T belongs to the class C_S of all operators T in C_0 such that the relation $T = \int \lambda E_\Delta^T(d\lambda)$ holds in the weak topology; (3) T belongs to the class C_U of all operators T in C_0 that have the properties: (a) the residual spectrum of T is void and E_Δ^T is a weakly continuous function of rectangles, (b) the set $K(E_\Delta^T)$ of all complex λ such that $E_\Delta^T(\lambda) \neq 0$ coincides with the point-spectrum of T . The algebra L of Laurent operators and an algebra F of functions are discussed. L is the image $p(F)$ of F under an isomorphism $F \rightarrow pF$.

PUR.02:005

Purdue U. Dept. of Mathematics, Lafayette, Ind.

CONVOLUTION OPERATORS WHICH ARE NOT OF SCALAR TYPE, by G. L. Krabbe. Apr. 30, 1958, 8p. (Technical note no. 5) (AFOSR-TN-58-396) (AF 18-(603)44) AD 154305; PB 140155
Unclassified

Additional motivation for extending the scope of the spectral theorem beyond Dunford's class of scalar type operators is presented. Let $G = \{0, \pm 1, \pm 2, \dots\}$ and let T be a bounded operator on $l_p = L^p(G)$, $1 < p \neq 2$. T is said to be of the scalar type if it is a spectral operator satisfying the relation $T = \int \lambda E(d\lambda)$, where E is the resolution of the identity for T . To any uniformly bounded transformation, there corresponds a family $\{E_\lambda\}$ of projectors. Set $\alpha = \pm 1$ and let $\tau_\alpha x$ be the translate $x_n + \alpha n \in G$ of the sequence $x = \{x_n\}_{n \in G}$. The operator $x \rightarrow \tau_\alpha x$ defined on l_p is not a scalar type operator, although it is a uniformly bounded transformation of the simplest kind. The Hilbert transformation H defined on l_p is not of the scalar type. Both H and τ_α belong to a class of convolution operators T .

PUR.02:006

Purdue U. Dept. of Mathematics, Lafayette, Ind.

CONVOLUTION OPERATORS THAT SATISFY THE

PUR.11:001

Purdue U. Dept. of Mathematics, Lafayette, Ind.

FUNCTIONS WITH GENERALIZED GRADIENT AND GENERALIZED SURFACES, by W. H. Fleming. Mar. 1957, 15p. incl. refs. (Technical note no. 1) (AFOSR-TN-57-134) (AF 49(638)18) AD 120490
Unclassified

Also published in Ann. Math. pura et appl., v. 44: 93-104, 1957.

According to a paper by K. Krickeberg [Ann. Math. pura et appl., v. 44: 105-133, 1957] the concepts of "gradient" of a function $f(x)$, $x = (x_1, \dots, x_k)$, with a compact support (say a fixed cube $K \subset R^k$) and whose first partial derivatives $\Phi = (\mu_1, \dots, \mu_k)$ are Radon measures in R^n and of "track of a closed generalized surface" are proved to be equivalent. In the present paper a new proof of this equivalence is given in terms of L. C. Young's theory, together with the result I. below. Let \mathcal{F} be the collection of all functions f as above and put $I(f) = V(\Phi)$, the total variation of Φ (thus $I(f) < +\infty$); let \mathcal{F}_N be the subcollection of all $f \in \mathcal{F}$ with $I(f) \leq N$. If E is any measurable set $E \subset K$, and f_E the characteristic function of E , then $P(E) = I(f_E)$ is a sort of "measure" of the boundary of E . Thus $P(E)$ is said to be the perimeter of E . Let $\mathcal{E}, \mathcal{E}_N$ be the collections of all measurable sets $E \subset K$ with $P(E) < +\infty$, $P(E) \leq N$ (Caccioppoli sets). With the usual

PUR.11:002, 003; PUR.03:07:008

l_1 topology \mathfrak{F}_N is a compact convex space and hence the convex closure of its extreme points (theorem of Krein-Milman). Also, by a result of G. Choquet, each element of \mathfrak{F}_N has an integral representation in terms of a measure carried by the set of extreme points. I. If $k = 2$ or 3 , and f is an extreme point of \mathfrak{F}_N , then there is a set $E \subset \mathfrak{F}_N$ with $f_E = \pm N^{-1} P(E)f$. For $k = 2$, E is a simple Jordan region, $E \subset K$, whose boundary is a rectifiable (simple closed) curve of Jordan length $L = P(E)$. (Math. Rev. abstract)

PUR.11:002

Purdue U. Dept. of Mathematics, Lafayette, Ind.

NONDEGENERATE SURFACES AND FINE-CYCLIC SURFACES, by W. H. Fleming. Nov. 1957, 18p. incl. refs. (Technical note no. 3) (AFOSR-TN-57-788) (AF 49(638)18) AD 136756 Unclassified

Also published in Duke Math. Jour., v. 26: 137-146, Mar. 1959.

A fine-cycle decomposition of surfaces in E_N space ($N \geq 2$) has been carried out for surfaces which are defined from finitely connected Jordan regions. Even if the fine-cycle elements are not nondegenerate, the surface S becomes nondegenerate if cuts are introduced in S at a finite number of points. A representation theorem for fine-cycle surfaces has been obtained for these not necessarily nondegenerate surfaces. A new proof is given of the equality of the Lebesgue area $L(S)$ and the Geöcze area for fine-cycle surfaces if $L(S)$ is finite.

PUR.11:003

Purdue U. Dept. of Mathematics, Lafayette, Ind.

IRREDUCIBLE GENERALIZED SURFACES, by W. H. Fleming. Nov. 1957, 42p. incl. refs. (Technical note no. 2) (AFOSR-TN-57-767) (AF 49(638)18) AD 136757 Unclassified

Also published in Riv. Matem. Univ. Parma, v. 8: 251-281, 1957.

Two main innovations are applied to the problem of irreducible generalized surfaces. First, conformal mapping for polyhedra of higher topological types was applied in a way similar to the author's recent extension of Morrey's theorem to 2-manifolds (Trans. Amer. Math. Soc., v. 90: 323-335, 1959). Second, the set of generalized surfaces of given topological type which admit a given set Γ of curves in space as boundary in the sense presented by L. C. Young (Memoirs Amer. Math. Soc. no. 17, 1955) is enlarged to include those which admit Γ as boundary in a certain limiting sense.

General conditions (irreducibility) are given under which an element of the larger set necessarily belongs to the smaller set and possesses a microrepresentation. Various improvements are made in the results of Young. Boundary identifications are pointwise and piecewise linear, instead of merely arcwise. Less restrictive assumptions are made about the set Γ of boundary curves.

PUR.03:007

Purdue U. [Dept. of Physics] Lafayette, Ind.

PARITY EXCHANGE SCATTERING, by D. C. Peaslee. Dec. 28, 1956, 3p. (AFOSR-TN-57-6) (AF 18(600)1579) AD 115037 Unclassified

The features of intrinsic parity exchange on nuclear scattering of K mesons existing as parity doublets is discussed. The elastic K-nucleon scattering amplitude has the (non-relativistic) form:

$$a = \alpha + \beta \sigma - n + \beta' \sigma \cdot t$$

where σ refers to nuclear spin. This form has certain interesting implications. The absence of any spin-independent pseudoscalar term α' means that parity exchange scattering should effectively be absent in K encounters with heavy nuclei, where $\langle \sigma \rangle \approx 0$. If parity exchange scattering is the dominant process in K-nucleon interactions, then K scattering on heavy nuclei would be relatively weak in comparison with K-nucleon scattering. It is suggested that polarization measurements on the recoil proton from K-p scattering would supply an unequivocal test of the parity doublet hypothesis.

PUR.03:008

Purdue U. Dept. of Physics, Lafayette, Ind.

ISOTOPIC SPIN SELECTION RULE $|\Delta I| = 1/2$ FOR DECAYS OF STRANGE PARTICLES, by M. Kawaguchi. Mar. 15, 1957 [16]p. incl. diagrs. tables, refs. (AFOSR-TN-57-131) (AF 18(600)1579) AD 120487 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 191, Apr. 25, 1957.

Also published in Phys. Rev., v. 107: 573-576, July 15, 1957.

Decay processes of strange particles are re-examined under the assumption of the selection rule $|\Delta I| = 1/2$, when all particles concerned have isotopic spins, but parity is not necessarily conserved. Some of the results obtained before still hold as they are, even if parity nonconservation is taken into consideration. However, the relation between the branching ratio

PUR.03:009 - PUR.03:012

$(\Sigma^+ \rightarrow p + \pi^0)/(\Sigma^+ \rightarrow n + \pi^+)$ and the ratio of lifetimes $\tau(\Sigma^-)/\tau(\Sigma^+)$ is changed by parity nonconservation. The experimental results on Σ particles may be interpreted as indicating comparable magnitudes for parity-conserving and parity-nonconserving terms. Some results based on $|\Delta I| = 1/2$ and $3/2$ are also discussed for these particles. (Contractor's abstract)

PUR.03:009

Purdue U. [Dept. of Physics] Lafayette, Ind.

PHOTOPRODUCTION OF K MESONS FROM SINGLE NUCLEONS, by M. Kawaguchi and M. J. Moravcsik. [1957] 17p. (AFOSR-TN-57-246) (AF 18(600)1579) AD 126544 Unclassified

Also published in Phys. Rev., v. 107: 563-569, July 15, 1957.

The lowest order perturbation calculations are carried out for K meson photoproduction from single nucleons. Results are given for scalar and pseudoscalar mesons, with or without anomalous magnetic moments for the nucleons and hyperons, and with scalar, pseudoscalar, vector, and pseudovector couplings. Numerical results are given assuming unity for the coupling constant. The difference between the present results and those carried out for pion photoproduction is due to the mass difference of the nucleons and hyperons, the larger ratio of the mesons mass to the nucleon mass, and the different values for the anomalous magnetic moments. The last of these effects is particularly striking and might be of practical significance when sufficient experimental information is available. (Contractor's abstract)

PUR.03:010

Purdue U. [Dept. of Physics] Lafayette, Ind.

POLARIZATION MEASUREMENTS AND THE UNIVERSAL FERMION INTERACTION, by D. C. Peaslee. June 27, 1957, 12p. refs. (AFOSR-TN-57-389) (AF 18(600)1579) AD 132464 Unclassified

Two possibilities are considered for maintaining the notion of a universal Fermion interaction (UFI) among the processes of (1) μ -e decay, (2) nuclear β -decay, (3) nuclear μ -capture, and (4) K_{e3} decay. If the 2-component neutrino with lepton conservation is adopted, the UFI must involve predominantly (VT) for nuclear β -decay, and there is a discrepancy of a factor of 2 in the magnitude of the coupling constant C_V as compared with μ -e decay; the coefficient C_T is arbitrary, and $C_S = C_P$ is small. The slight preliminary evidence available on $K_{\mu 3}$ and K_{e3} does not favor a dominant V

term. If the 2-component neutrino with lepton conservation is abandoned, an interaction of the (STP) form can be written which fits all present polarization measurements. This interaction can be definitely excluded in μ -e decay only by an absolute measurement of the μ -polarization direction or by observing 2 separate electron polarization terms in the μ -e process. In nuclear β -decay the most direct approach seems to be search for (VT) interference effects, either in a Fierz-type $1/W$ term in first forbidden spectra of allowed shape, or in the transverse polarization of electrons from oriented nuclei in allowed transitions containing both Fermi and Gamow-Teller parts. These 2 interference terms reflect respectively the real and imaginary parts of the (VT) interference. Further comments are made on similar measurements for processes 3 and 4. Under favorable circumstances, the assumption of a UFI might specify the intrinsic parity of the K relative to the π .

PUR.03:011

Purdue U. Dept. of Physics, Lafayette, Ind.

ON THE PION-ELECTRON DECAY, by M. Kawaguchi and K. Nishijima. [1957] 4p. (AFOSR-TN-57-628) (AF 18(600)1579) AD 144783 Unclassified

Also published in Phys. Rev., v. 108: 905-907, Nov. 1, 1957.

Attempts are made to calculate the branching ratio of π^+ into the e^+ and μ^+ modes. Experimentally the π^+ to e^+ decay has not been observed, but an experimental upper limit of 5×10^{-5} sec has been given for the branching ratio. The $\pi \rightarrow e + \nu + \gamma$ process with V and T couplings is used to find a lifetime for the tensor coupling of 8.6×10^{-4} sec, which leads to a branching ratio which is not inconsistent with the experimental upper limit. The γ decay of π^0 is studied and a lifetime of 0.5×10^{-15} sec is calculated.

PUR.03:012

Purdue U. [Dept. of Physics] Lafayette, Ind.

BETA DECAY MATRIX FROM THE QUASI- α MODEL. (Abstract), by D. W. Dorn and R. W. King. [1957] [1]p. (AF 18(600)1579) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc. Series II, v. 2: 26, Jan. 30, 1957.

Allowed beta decay transition probabilities provide a rigid test for low energy nuclear models. The

PUR.03:013 - PUR.03:016

supermultiplet formalism has remained the only means of obtaining qualitative accord with the experimental evidence on beta decay. In general, the predictions of j-j coupling models have been considerably worse. Since the quasi- α model in j-j coupling does bear some resemblance to the supermultiplet formalism in L-S coupling, it is conceivable that a strong spin-orbit coupling description can be maintained with improved beta decay matrix elements. Specific matrix elements in the d 5/2 and f 7/2 shells have been calculated; the improvement obtained suggests that wave functions constructed from the quasi- α model afford a better description of nuclei than those derived from the use of a "seniority" quantum number.

PUR.03:013

Purdue U. [Dept. of Physics] Lafayette, Ind.

Λ -NUCLEON FORCE WITH $S\Sigma = 3/2$ (Abstract), by M. T. Vaughn and D. C. Peaslee. [1957] [1]p. [AF 18(600)1579] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 39, Jan. 30, 1957.

Pion exchange Λ - N forces are estimated in accordance with the possibility that the spin of the intermediate Σ state may be 3/2. The Λ is taken to have $S = 1/2$ and the same parity as the Σ , and a phenomenological interaction operator ($S \cdot \sigma$) assumed with matrix elements proportional to Clebsch-Gordan coefficients for vector addition $1/2 + 1 = 3/2$. The term corresponding to V_2 in ordinary nuclear forces does not operate directly but only through mixing in Σ states. Its effect is therefore dependent on the structure of the nuclear core in a hyperfragment, but this structure dependence appears negligible in the present case. The Λ - N potential $(V_2)^2 + V_4$ in the region $ur = 1$ is attractive but only quite weakly spin-dependent.

PUR.03:014

Purdue U. [Dept. of Physics] Lafayette, Ind.

PHOTOPRODUCTION OF K-MESONS (Abstract), by M. Kawaguchi. [1957] [1]p. [AF 18(600)1579] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 39, Jan. 30, 1957.

The processes $\gamma + p \rightarrow K^+ + \Lambda^0$ and $\gamma + p \rightarrow K^0 + \Sigma^+$ are investigated in terms of the lowest order perturbation calculation, on the assumption that the nucleon-hyperon pair coupling is relatively weak. The $K + \Lambda$ cross sections are obtained straightforwardly by simple modifications of the results of photo-pion production. For example, (i) with $\Lambda = 1/2^+$ and $K = 0^+$, or $\Lambda = 1/2^-$ and $K = 0^-$, the result of $s(s)$ meson theory is available, and (ii) $ps(ps)$ theory for $\Lambda = 1/2^+$ and $K = 0^-$, or $\Lambda = 1/2^-$ and $K = 0^+$. The former shows a peak at forward laboratory angles and the latter does not. Therefore, if experiment could distinguish between a single one of these angular distributions and a superposition of the two, it would in principle be possible to decide whether or not the Λ, K are parity doublets. For production of $K + \Sigma$ the treatment is more complicated if the Σ spin is taken as 3/2.

PUR.03:015

Purdue U. [Dept. of Physics] Lafayette, Ind.

QUASI- α NUCLEAR SUBSTRUCTURE IN j-j COUPLING (Abstract), by R. W. King and D. W. Dorn. [1957] [1]p. [AF 18(600)1579] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 26, Jan. 30, 1957.

Empirical evidence on complex nuclei reveals, in addition to large spin-orbit forces, a tendency for two neutrons and two protons to form a particularly stable ("quasi- α ") structure. The j-j coupling shell model provides a description of strong spin-orbit effects; however, in all but a few simple nuclei, the model does not lead to uniquely determined wave functions. We have chosen to remove the nonuniqueness of j-j coupled wave functions by imposing the maximum amount of quasi- α structure permitted by strong spin-orbit coupling. The α -like structure is associated with two neutrons and two protons in an $S = T = 0$ substate; the antisymmetry of the total wave function assures that the substate is completely space-symmetric. The procedure of maximizing this α structure thus demands that the dominant parts of nuclear wave functions be formed by pairs of nucleons in relative $T = 1$, $S = 0$ and $T = 0$, $S = 1$ states with symmetrical space coupling. This type of pairing appears more realistic than that imposed by the "seniority" quantum number.

PUR.03:016

Purdue U. [Dept. of Physics] Lafayette, Ind.

SIGMA-NUCLEON $T = 3/2$ FORCE (Abstract), by M. T. Vaughn. [1957] [1]p. [AF 18(600)1579] Unclassified

PUR.03:017 - PUR.03:020

Presented at meeting of the Amer. Phys. Soc., St. Louis, Mo., Nov. 29-30, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 353, Nov. 29, 1957.

The sigma-nucleon force in the $T = 3/2$ state is computed in the static approximation for one- and two-pion exchanges. The resulting singlet and triplet central potentials satisfy $V^1 \approx 3V^3 < 0$; the tensor force is relatively weak. The V^1 is very similar to the 1S nucleon-nucleon potential but is about 10% larger in magnitude if the π coupling is equivalent to $\pi - N$, because of differences in the two-pion term. Sigma-nucleon binding is further enhanced by the increased mass of the sigma (relative to nucleon-nucleon); these two features are sufficient to yield an $n - \bar{\nu}$ binding of order 1 mev. If the $n - \bar{\nu}$ binding exceeds 1/2 mev, the $p - \bar{\nu}^+$ should also be bound. For a cutoff radius of order 0.35μ the K-exchange forces are negligible if $G_K^2/4\pi \approx 1$.

PUR.03:017

Purdue U. Dept. of Physics, Lafayette, Ind.

STATISTICAL DERIVATION OF NUCLEAR ROTATIONAL ENERGIES, by K. Kumar. [1958] [18]p. incl. diagrs. refs. (AFOSR-TN-58-188) (AF 18(600)1579) AD 152222
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 48-49, Jan. 29, 1958.

The nucleus is treated as a Fermi gas under the constraints of constant angular momentum and quadrupole moment. The deformation dependence of the nuclear moments of inertia is then derived on the basis of a model in which only the nucleons outside a certain spherical core produce all the angular momentum. The influence of the surface effects and the velocity dependent forces is also taken into account. Over-all agreement with the experimental data is obtained. (Contractor's abstract)

PUR.03:018

Purdue U. Dept. of Physics, Lafayette, Ind.

ON THE POSSIBILITY OF THE CHARGE DEPENDENT CORRECTION TO THE GRAVITATIONAL FORCE, by M. Kawaguchi. [1958] [5]p. incl. diagrs. (AFOSR-TN-58-189) (AF 18(600)1579) AD 152223
Unclassified

Also published in Nuovo Cimento, Series X, v. 8: 506-507, May 1, 1958.

The fourth-order Fermi interactions have been used to calculate a charge dependent correction to the gravitational force. The potentials for a single p-n pair interaction, a combination of two p-n pair interactions, and $\pi - \mu$ interaction have been calculated and found to have leading terms in r^{-2} instead of r^{-1} . It is concluded that the Fermi interaction is too small to observe and does not produce any detectible correction to the gravitational force.

PUR.03:019

Purdue U. Dept. of Physics, Lafayette, Ind.

POLARIZATION OF THE PROTON FROM PHOTODISINTEGRATION OF THE DEUTERON, by M. Kawaguchi. [1958] 11p. diagrs. tables, refs. (AFOSR-TN-58-584) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1579 and Atomic Energy Commission) AD 162104
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 222, May 1, 1958.

Also published in Phys. Rev., v. 111: 1314-1318, Sept. 1, 1958.

The transverse polarization of the outgoing proton from the photodisintegration of the deuteron is calculated in the angular momentum representation, without assuming any detailed interaction among particles. General formulas for the polarization as well as for the angular distribution are given in terms of the Racah coefficients. If we write the angular distribution in a form

$$a + b \sin^2 \theta (1 + 2c \cos \theta),$$

the polarization is given in terms of a, b, c, and the nucleon-nucleon scattering phase of the S, P, and D states under reasonable assumptions. By using experimental values of a, b, and c, and scattering phase shifts as much as available and also some theoretical estimates of the phase shifts, 20 to 30% polarization is expected for up to 40-mev gamma rays and 10 to 20% for 140-mev gamma rays over a wide range of angles in the center-of-mass system. (Contractor's abstract)

PUR.03:020

Purdue U. [Dept. of Physics] Lafayette, Ind.

INVERSE BETA DECAY AND THE TWO COMPONENT NEUTRINO, by R. W. King and J. F. Perkins. June

PUR.03:021 - PUR.03:023

1958, 11p. incl. diagrs. tables, refs. (Rept. no. UCRL-8337) (AFOSR-TN-58-622) (AF 18(600)1579)
AD 162151 Unclassified

Also published in Phys. Rev., v. 112: 963-966, Nov. 1, 1958.

Several procedures for calculating the average cross-section per antineutrino from U^{235} fission are given to test the predictions of the two-component neutrino theory. A firm lower limit of $\bar{\sigma}_p > 7 \times 10^{-44} \text{ cm}^2$ is deduced from the known decays of the fission products. Three different procedures, if weighted equally, give a "best value" of $\bar{\sigma}_p = 14 \times 10^{-44} \text{ cm}^2$ to be compared with the recently increased experimental value $\bar{\sigma}_p = 11 \pm 4 \times 10^{-44} \text{ cm}^2$. It is concluded that predictions of the two component neutrino theory are in accord with the experimental results on inverse beta decay.

PUR.03:021

Purdue U. Dept. of Physics, Lafayette, Ind.

UNIVERSAL WEAK BOSON AND FERMION INTERACTION, by M. Sugawara. [Oct. 1958] 19p. incl. refs. (AFOSR-TN-58-858) (AF 18(600)1579) AD 203664
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 83, Jan. 28, 1959.

Also published in Phys. Rev., v. 113: 1361-1366, Mar. 1, 1959.

A modified interpretation of an idea of divergenceless currents due to Feynman and Gell-Mann is investigated in detail in which some pairs of bosons (pions and K mesons) are assumed to exist, besides fermion pairs, among members exerting a universal weak interaction. In particular, we propose a pair of a neutral K meson and a charged pion, in addition to a pion pair and pairs of leptons, nucleons and some hyperons. Strong evidence for this pion-K-meson-pair is provided by its surprising fit to short-lived decay of neutral K mesons. An essential presumption is here that pion-muon-decay is consistent with the present scheme; its ratio pion-electron-decay is left unchanged. If we further assume a global symmetry of pion coupling to hyperons, and the K meson interaction is simply assumed as comparatively weaker, then our present scheme seems consistent with all known data on decays of strange particles as far as reliable estimation could have been made. A complete scheme of a universal weak interaction is not obtained uniquely, since we have no particular necessity nor ob-

jection to some pairs of particles, from available theoretical and experimental information. Some decay modes which are yet unobserved but are expected according to the present scheme are summarized in the final section. (Contractor's abstract)

PUR.03:022

Purdue U. Dept. of Physics, Lafayette, Ind.

DECAY OF HYPERONS AND MESONS FROM THE UNIVERSAL FERMION INTERACTION, by A. Fujii and M. Kawaguchi. [Sept. 1958] 22p. incl. diagrs. tables. (AFOSR-TN-58-921) (AF 18(600)1579) AD 204559
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 38, Jan. 28, 1959.

Also published in Phys. Rev., v. 113: 1156-1161, Feb. 15, 1959.

The decay of the hyperon, charged pion and kaon except $K_{\pi 3}^+$ is investigated on the basis of the universal V-A Fermi interaction together with the idea of the Gell-Mann tetrahedron, by treating the virtual baryon-antibaryon pair effect in a phenomenological way. It is shown that the decay rate of $K_{\pi 2}^+$ calculated by the parameters adjusted to the decay of π^+ , $K_{\mu 3}^+$ and $K_{e 3}^+$ is in agreement with experiment, thus suggesting a possible consistent picture of the model. (Contractor's abstract)

PUR.03:023

Purdue U. [Dept. of Physics] Lafayette, Ind.

ENERGY RELEASE FROM THE DECAY OF FISSION PRODUCTS AND THE ANTINEUTRINO SPECTRUM (Abstract), by J. F. Perkins and R. W. King. [1958] [1]p. (AF 18(600)1579) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 64, Jan. 29, 1958.

A calculation of energy release from the decay of U^{235} fission products has been made by examining in detail the individual decay schemes of the many nuclei involved. The very good agreement with experiment that has been obtained for times after shutdown $> 10^2$ sec speaks strongly for the validity and completeness of the input data for nuclei with half-lives $> 10^2$ sec. We are hence,

PUR.03:024; PUR.04:002

in a position to plot the distribution of beta decay end points with considerable accuracy for $E_{\beta} \text{ max} \lesssim 4 \text{ mev.}$

Comparisons are made with the assumed distribution of Muehlhause and Oleksa used in the calculation of the antineutrino flux from a reactor. Antineutrino energy spectra are also investigated as a function of operating time and time after shutdown.

PUR.03:024

Purdue U. [Dept. of Physics] Lafayette, Ind.

INVERSE BETA DECAY AND THE TWO COMPONENT NEUTRINO (Abstract), by R. W. King and J. F. Perkins. [1958] [1]p. [AF 18(600)1579] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 205, May 1, 1958.

The discrepancy between the experimental cross-section for neutrino absorption by protons as determined by Cowan and Reines and that predicted by the two component theory of the neutrino has usually been dismissed as due to the uncertainties involved in determining the spectrum of antineutrinos from fission products. From a complete summary of the known decay schemes of the fission products, we are able to establish a firm lower limit for the average cross-section per antineutrino

$\sigma_p = 7 \times 10^{-44} \text{ cm}^2$ (based on the two-component theory) which exceeds the experimental upper limit. We furthermore, offer a "best value" for the cross-section $\sigma_p = 17 \times 10^{-44} \text{ cm}^2$ that is several times larger than that found experimentally ($\sigma_p = 2.8 \pm 1 \times 10^{-44} \text{ cm}^2$).

Various improvements made on previous estimates of the antineutrino spectrum have served to widen rather than remove the discrepancies. Thus, it can be concluded that the existence of the disagreement between the two component theory and experiment is quite real and independent of the uncertainties in the spectrum of antineutrinos.

PUR.03:025

Purdue U. [Dept. of Physics] Lafayette, Ind.

WEAK DECAYS AND ISOTOPIC SPIN (Abstract), by D. C. Peaslee and M. Kawaguchi. [1958] [1]p. [AF 18(600)-1579] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 216, May 1, 1958.

Consequences are considered of expressing weak interactions in terms of the two independent isotopic spins characterizing baryons. There are then four independent coupling constants g for each class of charged lepton decays. Under this assumption the lepton decay of K mesons implies lepton decay of at least some baryons besides n and p , though these may still be slightly below presently observed levels with a suitable choice of the g 's. The absence of $\pi \rightarrow e + \gamma$ can be interpreted simply by saying one of the four g 's is zero; the absence of $K \rightarrow e + \gamma$ implies a similar rule which is less simple if the K -baryon interaction is not universal (as the π -baryon interaction is assumed). For weak pion emission the present scheme readily reproduces the $\Delta I = \frac{1}{2}$ results for Λ decay while at the same time allowing $\Delta I \geq \frac{1}{2}$ for Σ decay; it also predicts the Ξ lifetime directly from the known Λ lifetime. The slowing of $K^+ \rightarrow 2\pi$ relative to $K^0 \rightarrow 2\pi$ appears at least superficially fortuitous; but a wide range of charged neutral $K^0 \rightarrow 2\pi$ ratios (including the experimental value) can readily be encompassed.

PUR.03:026

Purdue U. [Dept. of Physics] Lafayette, Ind.

K_{e3} AND $K_{\mu 3}$ DECAY MODES, by M. Sugawara. [1958] 1p. [AF 18(600)1579] Unclassified

Published in Phys. Rev., v. 112: 2128, Dec. 15, 1958.

A viewpoint is presented in which some boson pairs are included among members which are exerting universal weak interactions on each other. The inclusion of K -meson-pion pairs leads to direct terms responsible for K_{e3} and $K_{\mu 3}$ decay modes. It is shown that these direct terms may result in too rapid decays of K_{e3} and $K_{\mu 3}$ if one assumes the universality of the weak-coupling constant, while the branching ratio of these decay modes is quite consistent with the data. (Contractor's abstract)

PUR.04:002

Purdue U. School of Aeronautical Engineering, Lafayette, Ind.

GENERALIZED VARIATIONAL APPROACH TO THE OPTIMUM THRUST PROGRAMMING FOR THE VERTICAL FLIGHT OF A ROCKET. PART I. NECESSARY CONDITIONS FOR THE EXTREMUM, by A. Miele. Mar. 1957 [47]p. incl. diagrs. refs. (Rept. no. A-57-1) (AFOSR-TN-57-173) (AF 18(603)69) AD 126467 Unclassified

Also published in Zeitschr. Flugwissensch., v. 6: 69-77, Mar. 1958.

The burning program for the vertical flight of a rocket-powered vehicle is analyzed. The results of previous theories are extended to cover the general problem of

PUR.04:003 - PUR.04:006

minimizing the difference $\Delta G = G_f - G_i$ between the final and initial values of an arbitrarily specified function $G(t, m, V, h)$ of time, mass, velocity and altitude. By using the indirect methods of the Calculus of Variations, it is shown that the totality of extremal arcs is composed of zero-thrust sub-arcs, sub-arcs to be flown with maximum engine output and variable-thrust sub-arcs. An explicit solution is determined for the optimizing mass flow of the rocket engine as a function of the local coordinates of the missile. Closed form solutions are obtained for the relationships between time, mass, altitude and velocity for the following particular cases: flight in vacuum, flight in a uniform atmosphere and flight in an isothermal atmosphere. The boundary value problem is investigated. Several numerical examples are included, having the object of illustrating the general procedures developed in the present report. (Contractor's abstract)

PUR.04:003

Purdue U. School of Aeronautical Engineering,
Lafayette, Ind.

GENERALIZED VARIATIONAL APPROACH TO THE OPTIMUM THRUST PROGRAMMING FOR THE VERTICAL FLIGHT OF A ROCKET. PART II. APPLICATION OF GREEN'S THEOREM TO THE DEVELOPMENT OF SUFFICIENCY PROOFS FOR PARTICULAR CLASSES OF SOLUTIONS, by A. Miele and C. R. Cavoti. Aug. 1957 [35]p. incl. diagrs. table. (Rept. no. A-57-2) (AFOSR-TN-57-652) (AF 18(603)69) AD 136638

Unclassified

Also published in Zeitschr. Flugwissensch., v. 6: 102-109, Apr. 1958.

The vertical flight of a rocket is analyzed in connection with the problem of determining the burning program which extremizes an arbitrary function of the final values of time, mass, altitude and velocity. The minimal or maximal character of the solutions is investigated. It is shown that the Legendre-Clebsch condition does not provide any information at points of the constant thrust sub-arcs and variable-thrust sub-arcs forming one extremal arc. An identical difficulty is encountered when applying the more stringent Weierstrass condition at points of the variable-thrust sub-arcs. By the use of a new and hitherto unexploited technique, based on Green's theorem, the afore-mentioned difficulties can be overcome. Rigorous sufficiency proofs can be developed for particular classes of solutions, in connection with linear variational problems of both the simplest type and the isoperimetric type. The cases of flight in a uniform atmosphere and flight in a vacuum are investigated. Concerning the latter, analytical proofs are supplied for both single-stage and multi-stage rockets. (Contractor's abstract)

PUR.04:004

Purdue U. School of Aeronautical Engineering,
Lafayette, Ind.

OPTIMUM THRUST PROGRAMMING ALONG ARBITRARILY INCLINED RECTILINEAR PATHS, by A. Miele and C. R. Cavoti. Dec. 1957 [30]p. incl. diagrs. (Rept. no. A-57-8) (AFOSR-TN-58-48) (AF 18(603)69) AD 148088

Unclassified

Presented at the ASME-ARS Aviation Conf., Dallas, Tex., Mar. 17-20, 1958.

Also published in Proc. Fourth annual meeting of the Amer. Astronaut. Soc., New York (Jan. 29-31, 1958), N. Y., Amer. Astronaut. Soc., 1958, p. 6-1 - 6-17.

Also published in Astronautica Acta, v. 4: 167-181, 1958.

A variational analysis of the theory of the thrust programming is presented for the case where a variable mass body is moving along an arbitrarily inclined rectilinear path. It is shown that the totality of extremal arcs is composed of zero-thrust sub-arcs, maximum thrust sub-arcs, and variable thrust sub-arcs. The optimum acceleration law is determined and some numerical example is presented emphasizing the engineering aspects of the present theory in connection with the flight analysis of rockets.

PUR.04:005

Purdue U. [School of Aeronautical Engineering]
Lafayette, Ind.

MINIMALITY FOR ARBITRARILY INCLINED ROCKET TRAJECTORIES, by A. Miele. [1958] [7]p. incl. diagr. (AFOSR-TN-58-202) (AF 18(603)69) Unclassified

Also published in Jet Propulsion, v. 28: 481-483, July 1958.

The problem of arbitrarily inclined rectilinear paths is analyzed by applying the Euler-Lagrange equations and the Legendre-Clebsch condition. The minimal properties of functional forms of the linear type are investigated by a new technique based on Green's theorem. While the Legendre-Clebsch condition alone is only indicative of the local behavior of the solution with respect to weak variations, this new technique supplies a complete, integral proof of necessary and sufficient conditions for the extremum.

PUR.04:006

Purdue U. School of Aeronautical Engineering,
Lafayette, Ind.

GENERAL VARIATIONAL THEORY OF THE FLIGHT

PUR.04:007 - PUR.04:010

PATHS OF ROCKET-POWERED AIRCRAFT, MISSILES AND SATELLITE CARRIERS, by A. Miele. Jan. 1958, 57p. incl. diagrs. refs. (Rept. no. A-58-2) (AFOSR-TN-58-246) (AF 18(603)69) AD 154148 Unclassified

Presented at Ninth Internat'l. Astronautical Congress, Amsterdam, Holland, Aug. 25-30, 1958.

Also published in *Astronautica Acta*, v. 4: 264-288, 1958.

Presentation of a basic theory for analyzing the optimum flight paths of rocket-powered aircraft, missiles, and satellites. The problem with three degrees of freedom is considered; it consists of the simultaneous optimization of the time history of lift, thrust modulus, and thrust direction. Special problems involving either one or two degrees of freedom are investigated by the introduction of additional constraining equations. For some of these problems closed form expressions are derived for the optimizing conditions. Furthermore, a complete formulation of the boundary conditions is supplied by means of the general transversality condition of the calculus of variations.

PUR.04:008

Purdue U. School of Aeronautical Engineering, Lafayette, Ind.

SOME VARIATIONAL SOLUTIONS TO ROCKET TRAJECTORIES OVER A SPHERICAL EARTH, by A. Miele and J. O. Cappellari, Jr. Nov. 1958, 29p. incl. refs. (Rept. no. A-58-9) (AFOSR-TN-58-1012) (AF 18(603)69) AD 206155 Unclassified

A rocket-powered vehicle moving over a rotating, spherical earth is considered in connection with problems of constant altitude, vertical, and gliding flight. Closed form solutions are obtained for the optimizing condition associated with the extremal trajectories of either constant altitude flight or vertical flight. A general iteration procedure, having particular interest for hypersonic vehicles, is presented for the extremal solution in connection with gliding flight. (Contractor's abstract)

PUR.04:009

Purdue U. School of Aeronautical Engineering, Lafayette, Ind.

MATHEMATICAL THEORY OF THE OPTIMUM TRAJECTORIES OF A ROCKET, by A. Miele. Final rept. Nov. 1958, 35p. incl. refs. (Rept. no. A-58-10) (AFOSR-TR-58-154) (AF 18(603)69) AD 206361 Unclassified

An investigation of a wide class of variational problems of interest in rocket flight has been developed. The scientific results are reviewed, with particular regard to the following topics: (1) optimum thrust programming for level flight, (2) optimum thrust programming for vertical flight, (3) optimum thrust programming for arbitrarily inclined rectilinear trajectories, (4) non-lifting trajectories, (5) gliding paths, (6) interception paths, (7) vacuum flight trajectories, (8) Legendre-Clebsch, Weierstrass, and Jacobi-Mayer conditions, and (9) variational problems with consideration of the variable gravitational field and rotation of the Earth. (Contractor's abstract)

PUR.04:010

Purdue U. School of Aeronautical Engineering, Lafayette, Ind.

STATIONARY CONDITIONS FOR PROBLEMS INVOLVING TIME ASSOCIATED WITH VERTICAL ROCKET TRAJECTORIES, by A. Miele. Mar. 15, 1958, 6p. (AF 18(603)69) Unclassified

Published in *Jour. Aero/Space Sciences*, v. 25: 467-469, July 1958.

PUR.04:007

Purdue U. School of Aeronautical Engineering, Lafayette, Ind.

TOPICS IN DYNAMIC PROGRAMMING FOR ROCKETS, by A. Miele and J. O. Cappellari, Jr. July 1958 [65]p. incl. diagrs. (Rept. no. A-58-5) (AFOSR-TN-58-685) (AF 18(603)69) AD 162218 Unclassified

Also published in *Zeitschr. Flugwissensch.*, v. 7: 14-21, Jan. 1959.

Topics associated with the programming of optimum trajectories for rocket-powered vehicles are investigated. Attention was devoted to stationary conditions for problems involving time associated with vertical trajectories. A simple approximate relationship was computed between altitude and Mach number which holds for all drag functions, regardless of the end-conditions and of the analytical configuration of the functional form to be extremized. For the Legendre-Clebsch condition for level flight, a discussion is presented of the second variation in connection with the optimization of the thrust modulus for constant altitude flight. Methods of programming thrust direction with aerodynamic forces, and thrust modulus in vacuum flight were investigated. Maximum range in vacuum flight was determined for the case where both the initial and final path inclinations are free and the velocity modulus at final point is also free. (Contractor's abstract)

PUR.05:023-025; PUR.06:004, 005

This paper extends an earlier investigation by the author of trajectories of minimum propellant consumption involving time. Due to detection of a first integral for an isothermal atmosphere involving time variants, a simple approximate relationship is noted between altitude and Mach number. This relationship holds (with a precision of 3-4%) for all drag functions, regardless of end-conditions and of the analytical configuration of the functional form to be extremized.

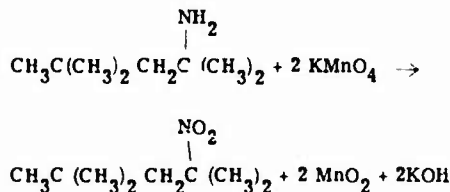
PUR.05:023

Purdue U. [School of Chemical and Metallurgical Engineering] Lafayette, Ind.

2-NITRO-2,4,4-TRIMETHYLPENTANE, by N. Kornblum and W. J. Jones. [Mar. 1957] 3p. incl. table. (AFOSR-TN-57-119) (AF 18(600)310) AD 120472 Unclassified

A procedure for the synthesis of 2-nitro-2,4,4-trimethylpentane, (I) from 2-amino-2,4,4-trimethylpentane (II) is described. 25.8g (0.2 mole) of (II) is dissolved in acetone and reacted with KMnO_4 at 25-30°C for 48 hrs.

After purification 24.3g of (I) was obtained. The procedure has been used to synthesize a wide variety of tertiary nitro paraffins.



PUR.05:024

Purdue U. [School of Chemical and Metallurgical Engineering] Lafayette, Ind.

A NEW AND SELECTIVE METHOD OF OXIDATION, by N. Kornblum, J. W. Powers and others. [July 16, 1957] 3p. incl. table. (AFOSR-TN-57-794) (AF 18(600)310) AD 148026 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 6562, Dec. 20, 1957.

A method is described for oxidizing alkyl bromides to the corresponding aldehyde, ketone or acid. The oxidation is achieved by dissolving the halide in dimethyl sulfoxide at room temperature. As an example an 84% yield of p- $\text{BrC}_6\text{H}_4\text{COCHO}$ was obtained from the reaction with p-Bromophenacyl bromide. The simple procedure described cannot be satisfactory with benzyl bromides. However, by raising the temperature, and using acetonitrile as a solvent, pure p-nitrobenzaldehyde has been obtained in 48% yield from p-nitrobenzyl bromide.

PUR.05:025

Purdue U. [School of Chemical and Metallurgical Engineering] Lafayette, Ind.

ALIPHATIC NITRO COMPOUNDS AND THEIR DERIVATIVES, by N. Kornblum. Final rept. June 2, 1952-Oct. 31, 1957. May 20, 1958, 9p. incl. refs. (AFOSR-TR-58-62) (AF 18(600)310) AD 158233

Unclassified

This report summarizes previous research concerned with the fundamental chemistry of aliphatic and alicyclic nitro compounds and their derivatives. A bibliography of the technical notes and journal publications which give details of the work are included.

PUR.06:004

Purdue U. School of Chemical and Metallurgical Engineering, Lafayette, Ind.

DIFFUSION PHENOMENA IN PRESSURE WELDING, by A. G. Guy and A. L. Eiss. Apr. 15, 1957, 1v. incl. illus. diagrs. tables, refs. (Rept. no. 6) (AFOSR-TN-57-225) (AF 18(600)1463) AD 126523 Unclassified

Also published in Welding Jour. Research Suppl. 1-8, Nov. 1957.

A study was made of the pressure welding of "sandwich" specimens and of the diffusion processes that occur during subsequent heating of these specimens. Conventional wire markers were unnecessary since impurity particles at the weld interfaces served this purpose. Sandwich specimens were made using several combinations of copper and brass, various surface preparations, welding pressures and welding temperatures. Several characteristics of the weld interfaces were studied such as width, straightness, and parallelism. Welded specimens were given diffusion heat treatments under various conditions to obtain information on the transport of zinc along the weld interface. "Extra" interfaces were observed in many of the specimens. (Contractor's abstract)

PUR.06:005

Purdue U. School of Chemical and Metallurgical Engineering, Lafayette, Ind.

STEADY STATE DIFFUSION IN SUBSTITUTIONAL SOLID SOLUTIONS, by A. S. Yue and A. G. Guy. Jan. 2, 1957, 17p. incl. illus. diagrs. tables, refs. (Rept. no. 5) (AFOSR-TR-57-10) (AF 18(600)1463) AD 120407

Unclassified

Presented at meeting of the Amer. Inst. of Mining, Metallurgical and Petroleum Engineering, Feb. 1958.

PUR.06:006 - PUR.06:008

Also published in Trans. Metall. Soc. AIME, v. 212: 107-112, Feb. 1958.

A study was made of the effects of a prolonged flux of zinc atoms through the α solid solution of zinc in copper. The experimental arrangement consisted essentially of a copper disk about 0.01 in. thick, at one of whose surfaces a gaseous atmosphere containing zinc atoms was maintained, and at the other surface a gaseous atmosphere with a minimum of zinc atoms was maintained. During prolonged exposure at high temperatures the zinc content of the copper disk gradually built up to the steady-state concentration and then remained at this value. The concentration distribution curves for various conditions were determined by chemical analyses. The results showed that the condition of steady-state diffusion was achieved. The diffusion coefficients calculated from the experimental data, although not of high precision, agreed with the values obtained by other workers using unsteady-state methods. Relatively slight porosity developed in the specimens in the course of diffusion. (Contractor's abstract)

PUR.06:006

Purdue U. [School of Chemical and Metallurgical Engineering] Lafayette, Ind.

EFFECT OF PRESSURE ON THE DIFFUSION OF ZINC IN ALPHA BRASS, by A. G. Guy and C. Spineili. Jan. 15, 1958, 6p. incl. diagrs. tables, refs. (Rept. no. 7) (AFOSR-TN-58-85) (AF 18(600)1463) AD 148134
Unclassified

Also published in: Welding Jour., v. 37: 524s-526s, Nov. 1958.

It has been reported that the diffusion of zinc in brass changes radically as the pressure is varied over a range of relatively low pressures. In an attempt to duplicate this work, sandwich diffusion specimens of copper between brass were heated to 850°C under uniaxial compression for 7 hrs. No difference in diffusion behavior was observed for pressures of 9 or 142 psi. It is suggested that the conflicting results can be explained by transport of zinc along weld interfaces in specimens welded and diffused at lower pressures. (Contractor's abstract)

PUR.06:007

Purdue U. School of Chemical and Metallurgical Engineering, Lafayette, Ind.

DIFFUSION OF ZINC FROM THE VAPOR PHASE INTO

COPPER-ZINC AND SILVER-ZINC ALLOYS, by A. G. Guy. Jan. 31, 1958 [17]p. incl. diagrs. table, refs. (Rept. no. 8) (AFOSR-TN-58-282) (AF 18(600)1463) AD 154184
Unclassified

Diffusion measurements were performed using heated samples of copper-zinc and silver-zinc alloys exposed to a cooler zinc vapor reservoir. Natural markers at the initial surfaces of the specimens were "trapped" under a thin electroplate and their depth of burying was measured after diffusion. The ratio of diffusivities of the two components determined from these data and the chemical diffusion coefficient calculated by the Matano method agreed with previously reported results. The line of markers was found to be irregular and was often discontinuous as grain boundaries were crossed.

PUR.06:008

Purdue U. [School of Chemical and Metallurgical Engineering] Lafayette, Ind.

STUDY OF SUBSTITUTIONAL DIFFUSION, by A. G. Guy. Final rept. Jan. 31, 1958 [9]p. incl. refs. (Rept. no. 9) (AFOSR-TR-58-47) (AF 18(600)1463) AD 154186
Unclassified

Steady-state diffusion was produced in a substitutional solid solution (item no. PUR.06:005). Two theoretical studies were important preliminaries to this research: (1) consideration of the mathematics of diffusion prior to and during steady-state diffusion (item no. PUR.06:002) and (2) devising an approximate method of calculation which permits a correction to be made for the variation of the diffusion coefficient with concentration (item no. PUR.06:003). The study of the Kirkendall effect in sandwich specimens was devoted principally to the welding phenomena involved in producing the specimens. A comprehensive study (item no. PUR.06:004) was made of the pressure welding of specimens and of the diffusion processes that occur during subsequent heating of these specimens. An alternative experimental technique to the usual sandwich specimen was studied for use in obtaining reproducibility and precision in measuring the Kirkendall shift in diffusion specimens; the technique was that of vapor-phase diffusion (item no. PUR.06:007). Three special pieces of equipment were built in connection with the research: a laboratory vacuum furnace; a precision, measuring metallurgical microscope; (item no. PUR.06:001) and special apparatus for welding studies.

RCA.01:003; RRL01:007;
RRL02:001, 002

RCA.01:003

Radio Corp. of America. [David Sarnoff Research Center] Princeton, N. J.

ON THE EMISSION MECHANISM OF COLD CATHODE ARCS, by K. G. Hernqvist. [1958] [11]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-521) [AF 18(600)-1239] AD 136651 Unclassified

Also published in Phys. Rev., v. 109: 636-646, Feb. 1, 1958.

A new theory for the electron-emission mechanism of cold-cathode arcs is proposed in which excited atoms play a predominant role as a source for ion generation in the vicinity of the cathode surface. The processes of resonance ionization of excited atoms at the cathode surface are considered. Special emphasis is given to the dispersed (or D-type) arc, which operates with a relatively low emission-current density. An analysis of the D-type of arc is given based on the proposed theory. The rapid decrease of electron plasma temperature and population of excited atoms during arc-current interruption offer an explanation for the short extinguishing time of cold-cathode arcs. (Contractor's abstract)

Reaction Motors, Inc., Denville, N. J. see
Thiokol Chemical Corp. Reaction Motors, Inc.,
Denville, N. J.

RRL01:007

Reed Research, Inc., Washington, D. C.

TRANSIENT MOTION OF A VISCO-ELASTIC RECTANGULAR PLATE IN FLUID MEDIA, by G. C. K. Yeh and J. Martinek. May 27, 1957, 23p. incl. tables. (Technical note no. 5) (AFOSR-TN-57-269) [AF 18(600)1382] AD 126568 Unclassified

Also published in Proc. Third U. S. Nat'l Congress of Appl. Mech., Brown U., Providence, R. I. (June 11-14, 1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 701-707.

An equation of motion for the linear bending vibration of a thin plate of a visco-elastic material of Maxwell's type as derived previously by the authors is solved for transient motions of simply-supported and clamped rectangular plates. The deflection can then be expressed as the linear combination of a set of time functions and a set of space functions. The time functions have the same forms for both cases and are in terms of the roots of a cubic algebraic equation for each mode. The space functions are those for the corresponding problems of free vibrations of purely elastic plates in vacuum and have been solved exactly for a simply-supported plate and approximately for a clamped plate by other authors.

Damped oscillation is possible only when the cubic equations have complex roots. Then the natural frequencies depend on the natural frequencies of the corresponding purely elastic plate of the same size and same boundary conditions in vacuum, on the elasticity constants, viscosity coefficients, area density and thickness of the plate and on the densities and wave velocities of the surrounding fluid media. When the cubic equations have real roots only, the motion is simply damped out without oscillation. (Contractor's abstract)

RRL02:001

Reed Research, Inc., Washington, D. C.

HEAT TRANSFER IN TURBULENT PIPE FLOW, by R. R. Hunziker. Apr. 14, 1957, 77p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-57-219) [AF 18(603)104] AD 126517 Unclassified

Also published in Jour. Franklin Inst., v. 265: 205-225, Mar. 1958.

Heat transfer to and from fully developed turbulent flow in a circular pipe and between parallel plates is analyzed. The corresponding boundary value problems for temperature distribution in circular pipe and parallel plates are solved by application of Laplace's transformation. The use of Pai's velocity and correlation distribution allow a consistent determination of the eddy diffusivity of heat $\epsilon_H = \alpha \epsilon_M$. With the classic hypothesis $\alpha = 1$ a new and better fitting to the experimental Nusselt number data for liquid metals is obtained. (Contractor's abstract)

RRL02:002

Reed Research, Inc., Washington, D. C.

HEAT TRANSFER IN TURBULENT PIPE FLOW WITH VOLUME HEAT SOURCES, by J. S. Florio and R. R. Hunziker. Apr. 14, 1957, 45p. incl. diagrs. refs. (Technical note no. 2) (AFOSR-TN-57-220) [AF 18(603)104] AD 126518 Unclassified

Heat transfer to and from fully developed turbulent flow containing volume heat sources within the fluid is analyzed. The corresponding boundary value problems for the temperature distribution in a circular pipe and in flow between parallel plates are solved by application of the Laplace transformation. The distributions of local Nusselt number over the walls for various heat source intensities σ^*/μ^* are determined. Prandtl's

"heat source theorem" is generalized for fluid containing real volume heat sources, giving the asymptotic distribution of temperature as proportional to the velocity profile. Previous data are included to give a particular case for the source intensity $\sigma = 0$. (Contractor's abstract)

RRL 02:003-005; RPL 01:008

RRL 02:003

Reed Research Inc., Washington, D. C.

TRANSLATION OF A DISCUSSION BETWEEN E. MOHR AND E. FUES AND CRITICAL REMARKS ON THIS DISCUSSION, by J. Martinek. Mar. 15, 1957, 1v. incl. diagrs. refs. (AF 18(603)104) Unclassified

Four papers from German technical journals are translated and critically reviewed by J. Martinek. They are: I. On the Navier-Stokes Stress Tensor for Viscous Fluid Flow, by E. Mohr. *Luftfahrt-Forschung*, v. 18:

327⁺, 1941. An examination of the equations of Navier-Stokes are made in the light of Maxwell's concept of friction. In this connection, the possibility of a different equation is indicated. II. Is There Any Vortex Friction?, by E. Fues. *Zeitschr. für Physik*, v. 118:

409⁺, 1941-1942. In repetition of a well-known gas kinematic derivation, it is demonstrated that internal friction is connected with the correlation of the velocity components for the secondary motion. A typical example is presented showing why there is distortional friction, but not vortex friction. III. Remarks on the Paper by E. Fues, Is There Any Vortex Friction?, by E. Mohr. *Zeitschr. für Physik*, v. 119: 575-580, 1942. By means of simple flows, a "few further reasons" are presented indicating an asymmetric stress matrix. Also, an attempt is made to show that the stresses which have been computed by Fues belong to a symmetric matrix; however, these stresses are negligible in first approximation when compared to those stresses created by the transport of macroscopic order of magnitudes of motion, and which evolve from an asymmetric matrix. IV. Is There Any Vortex Friction? II. Reply to the Criticism of E. Mohr, by E. Fues. *Zeitschr. für Physik*, v. 121, 1943. In this reply, the "further reasons" enumerated by Mohr for an asymmetric stress tensor in fluids are repudiated.

RRL 02:004

Reed Research, Inc., Washington, D. C.

ON TURBULENT FLOW AND EDDY HEAT TRANSFER DIFFUSIVITY IN A PIPE, by R. R. Hunziker and J. S. Florio. [1957] [3]p. incl. diagr. refs. (AF 18(603)104) Unclassified

Published in *Jour. Aeronaut. Sciences*, v. 24: 782-784, Oct. 1957.

In his analysis of the flow in a circular pipe or between parallel plates, Pai considers simplifying hypotheses which allow him to write the Reynolds equations in the form first given by Kampé de Fériet for parallel plates. As in the case of the parallel plates, the equations for the circular pipe reduce to a pair of independent equations which are insufficient to determine uniquely the five related dynamical magnitudes charac-

terizing the flow. The use of Pai's polynomial distributions allows a consistent determination of the eddy diffusivity for heat $\epsilon_H = \alpha \epsilon_M$ on the basis of the "momentum transfer theory" and with a minimum of assumptions.

RRL 02:005

Reed Research, Inc., Washington, D. C.

HEAT TRANSFER AND REYNOLDS' ANALOGY IN A TURBULENT FLOW WITH HEAT RELEASE, by R. R. Hunziker. [1958] [9]p. incl. refs. (AF 18(603)104) Unclassified

Published in *Zeitschr. Angew. Math. Phys.*, v. 9A: 307-315, Nov. 25, 1958.

A mathematical study was made of heat transfer in a turbulent fluid flowing in a circular pipe in which sources of heat are present in the fluid. The solution of the boundary value problem is indicated, and it is shown that Reynolds' analogy, relating heating transfer and momentum in turbulent flow, can be extended to a heat-releasing flow, allowing a series solution approximation to the problem.

RPL 01:008

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

AN ELECTRIC-TANK ANALOGY SOLUTION OF A LINEARIZED THEORY FOR THE NORMAL-FORCE ON A SLENDER CLOSED BODY-OF-REVOLUTION, by W. B. Brower, Jr. Feb. 8, 1957, 49p. incl. illus. diagrs. table, refs. (Rept. no. TR-AE-5701) (AFOSR-TN-57-43) (AF 18(600)499) AD 115081 Unclassified

The problem considered is the determination of the normal-force on a slender closed body-of-revolution slightly inclined to the main stream. A theory is formulated which represents the mechanism of normal-force generation by a vortex sheet in the wake. The magnitude and distribution of vorticity is determined by imposing a new boundary condition on the body tangential velocity along the zero-meridian line due to the combined effects of the transverse-flow and the vortex sheet. The electric-tank analogy is employed to obtain the solution for one body configuration, that of a paraboloid of revolution, fineness-ratio 5. In addition, the case of the body in a classical Munk-flow is computed. Results for the loading coefficient, normal-force distribution and integrated normal-force coefficient are given. Comparisons are made with wind-tunnel results for slender bodies and with an unpublished theory of von Kármán. It is concluded that the slope of the normal-force-curve depends mainly on two parameters of the stern geometry, the stern-fineness-ratio and the shape of the stern meridian-line.

RPL 01:009; RPL 02:002;
RPL 03:005-007

RPL 01:009

Rensselaer Polytechnic Inst. Dept. of Aeronautical
Engineering, Troy, N. Y.

ELECTRIC ANALOGY FOR INCOMPRESSIBLE FLOW.
Final rept. Feb. 15, 1957, 3p. (AF 18(600)499)

Unclassified

A review is made of the objectives of this task and the reports written under it.

RPL 02:002

Rensselaer Polytechnic Inst. Dept. of Aeronautical
Engineering, Troy, N. Y.

A STUDY OF VORTEX PRODUCTION IN PIPE FLOW,
by G. Delforge. Apr. 1958, 59p. incl. illus. diagrs.
tables, refs. (Rept. no. TR-AE-5805) (AFOSR-TN-57-60)
(AF 18(600)681) AD 158205

Unclassified

A brief review is presented of the Theodorsen theory which describes the origin and basic structure of turbulence. The experimental procedure used and results obtained in attempting to find the basic structure occurring when a flow is transformed from a laminar to a turbulent nature by the use of artificial disturbances, and verification of results obtained by other investigators are given. From the investigation conducted, it was found that the horseshoe-shaped vortex does exist in laminar pipe flow, for the range of Reynolds numbers investigated, when the flow is suddenly interrupted by an artificial disturbance. The sequence of events following the formation of this system of vortices to transition compares with that given by Theodorsen. The inverse relation between the disturbance Reynolds number and transition Reynolds number as predicted by Theodorsen was found to exist. From visual observations, the basic structure of the vortices formed when a flow is transformed from a laminar to a turbulent state without artificial disturbances present appears to be similar to that obtained with artificial disturbances. The above results agree favorably with those found by other investigators. (Contractor's abstract)

RPL 03:005

Rensselaer Polytechnic Inst. Dept. of Aeronautical
Engineering, Troy, N. Y.

ON THE ACTION OF BLOWING AIR OVER A SLOTTED FLAP, by K.-T. Yen and J. W. Bursik. Dec. 1956, 13p. diagrs. (Rept. no. TR-AE-5605) (AFOSR-TN-57-69)
(AF 18(600)992) AD 120412

Unclassified

The deflection of two streams possessing different velocities when a curved surface is inserted into one of the streams was studied. The analysis is based on the

assumption that the two streams, both of finite width, will always be in contact. The main interest is in the location of the "separation points" R and S, i.e., how they will be affected by the presence of a second stream II. Results are given showing the qualitative effect upon the location of the "separation points" and the flow patterns when a second stream II is introduced. A complete solution of the problem is not attained because of mathematical difficulties. Lighthill's problem and results are summarized.

RPL 03:006

Rensselaer Polytechnic Inst. Dept. of Aeronautical
Engineering, Troy, N. Y.

ON THE INDUCTION AND MIXING IN A DUCT, by K.-T. Yen and V. Oskay. Dec. 1956, 21p. diagrs. (Rept. no. TR-AE-5601) (AFOSR-TN-57-107) (AF 18(600)992) AD 120459

Unclassified

The induction problem in a duct is studied in this report. In Part I, attention is directed to the effect of change in pressure and flow patterns caused by the deflection of the inducing stream. Potential theory for an incompressible flow is used and the compressibility effect is corrected by the Kármán-Tsien method. The mass flow rate ratio is shown to depend on two parameters -- the width ratio of the inducing stream and the induced stream, and the deflection angle of the jet. Qualitative agreement with experimental results is obtained. In Part II, a comparison is made between a constant pressure and a constant area mixing duct, for the optimum induction effect. In addition, a method is proposed which may be used to correct the mass flow rate ratio, as obtained in Part I, for the diffuser efficiency. (Contractor's abstract)

RPL 03:007

Rensselaer Polytechnic Inst. Dept. of Aeronautical
Engineering, Troy, N. Y.

ON A SMALL PERTURBATION TECHNIQUE FOR COMPRESSIBLE ROTATIONAL FLOWS, by K.-T. Yen and A. V. Farmer. Mar. 1957, 25p. diagr. (Rept. no. TR-AE-5702) (AFOSR-TN-57-160) (AF 18(600)992) AD 126452

Unclassified

A small perturbation technique for compressible inviscid flows has been developed using generalized coordinates. Application has been made to some simple compressible flow problems, both irrotational and rotational. The effect of a vorticity distribution of a specific form on the pressure distribution has been determined. Only subsonic flows have been considered. Further extension of this study to supersonic and more general types of flow problems is recommended. (Contractor's abstract)

RPL 03:008; RPL 05:004-007

RPL 03:008

Rennselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

COANDA EFFECT, by K.-T. Yen. Final rept. Jan. 31, 1957 [8]p. incl. diagr. refs. (AFOSR-TR-57-16) (AF 18(600)992) AD 120442 Unclassified

The study of the Coanda Effect was performed to achieve a clear understanding of the basic mechanism underlying this effect and its possible extension to high speed flow. In its practical side, the purpose was to evaluate the potential benefit and possible utilization of this effect in connection with some aerodynamic or propulsive devices. Only a two-dimensional study of this problem was made, but both compressibility and viscosity effects were considered whenever possible.

RPL 05:004

Rennselaer Polytechnic Inst. [Dept. of Aeronautical Engineering] Troy, N. Y.

VIBRATIONAL RELAXATION PHENOMENA IN A SHOCK TUNNEL, by W. Lick and T.-Y. Li. June 1957, 21p. illus. (Rept. no. TR-AE-5704) (AFOSR-TN-57-346) (AF 18(600)1591) AD 132419 Unclassified

Investigation is made of the effect of the vibrational heat capacity lag on the steady flow in a shock tunnel of gas in which specific heats are assumed to be a function of temperature and time. The investigation is restricted to temperatures below about 5000°R where the vibrational degrees of freedom are the only inert degrees of freedom. The energy content and the adjustment to equilibrium of the various degrees of freedom are discussed. The basic equations of state, energy, momentum, continuity, and relaxation are simplified. Three types of flow are considered: equilibrium, relaxed, and frozen flow. Conditions behind the incident shock and before expansion are assumed identical in all cases. A numerical example is worked out to compare the properties of an imperfect gas in the 3 cases for a particular shock tunnel. The resulting calculations show that the vibrational heat capacity lag has a considerable effect on the temperature and Mach number in the test section. The irreversibility of the process increases the final temperature several hundred degrees and decreases the Mach number considerably from that predicted by equilibrium flow. However, the final temperatures and Mach numbers have little meaning when the relaxation times are long compared with the time required for passage through the test section. To minimize the effect of heat capacity lag, a lower expansion rate should be used.

RPL 05:005

Rennselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

ASYMPTOTIC INTEGRATION OF SHOCK TUBE BOUNDARY LAYER EQUATIONS, by W. Lick. July 1957, 13p. incl. table. (Rept. no. TR-AE-5705) (AFOSR-TN-57-610) (AF 18(600)1591) AD 136600 Unclassified

The compressible boundary layer equations for the case of a shock wave propagating into a stationary fluid bounded by a wall are integrated by an asymptotic method first introduced by Meksyn (Proc. Roy. Soc. (London), A, v. 231: 274, 1955) for the usual case of a compressible boundary layer on a semi-infinite plate. Arbitrary constant Prandtl number and viscosity proportional to the temperature are assumed. Simple algebraic equations are obtained from the momentum and energy equations. The results of comparatively rapid calculations for skin friction and heat transfer agree closely with previous numerical calculations made by the NACA. (Contractor's abstract)

RPL 05:006

Rennselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

SHEAR FLOW PAST A CIRCULAR CYLINDER IN AN INCOMPRESSIBLE FLUID OF SMALL VISCOSITY, by R. Duffy and T.-Y. Li. Oct. 15, 1957, 29p. incl. diagrs. (Rept. no. TR-AE-5707) (AFOSR-TN-57-715) (AF 18(600)1591) AD 136708 Unclassified

The boundary layer characteristics about a circular cylinder in an incompressible fluid stream of symmetrical velocity distribution have been examined. Boundary layer results are expressed in the form of an infinite series expansion in terms of the free stream velocity distribution and the distances normal to and along the body surfaces. Preliminary results indicate that small free stream vorticity acts in a manner similar to induced pressure gradients along the body surface and as such have pronounced effects on boundary layer separation, boundary layer growth and shear stress. (Contractor's abstract)

RPL 05:007

Rennselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

INVISCID FLOW FIELD AROUND A BLUNT BODY AT HYPERSONIC SPEEDS. PART I. THE STAGNATION POINT REGION, by T.-Y. Li. Sept. 7, 1957 [64]p. incl. diagrs. (Rept. no. TR-AE-5706) (AFOSR-TN-57-758) (AF 18(600)1591) AD 136747 Unclassified

RPI.05:008 - RPI.05:010

The inviscid hypersonic flow in the stagnation point region on a blunt body of revolution was studied, with particular emphasis on finding out the effects of the body curvature. Geometrical considerations led to the conclusion that the blunt nose could be treated as essentially spherical. In the blunt nose region, the differential equation for the stream function was derived. A stagnation point approximation solution was obtained, which, for small values of the density ratio ($k < 0.10$), yielded numerical results in excellent agreement with the exact solution. The results were compared with the simple theory of Li-Geiger, which neglected the body curvature effects. The major effects were to (1) increase the shock detachment distance over the theoretical value predicted by Li-Geiger, (2) provide a pressure relief on the body surface as predicted in the Newtonian-plus-centrifugal force formula, (3) increase the value of the nondimensional velocity gradient at the stagnation point over the value obtained by Li-Geiger, and (4) modify the velocity distribution within the shock layer. Numerical results of velocity distribution, surface pressure distribution, vorticity distribution, streamlines, detachment distance, and nondimensional velocity gradient at the stagnation point were obtained. (ASTIA abstract)

RPI.05:008

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

STAGNATION POINT OF A BLUNT BODY IN HYPERSONIC FLOW, by T.-Y. Li and R. E. Geiger. [1957] [8]p. incl. diagrs. [AF 18(600)1591] Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 25-32, Jan. 1957.

Whereas Hayes ["Hypersonic flow fields at small density ratio" Ramo-Wooldridge Corp., May 1955] has treated the hypersonic flow about blunt bodies, the present authors consider the stagnation point region in more detail. Specifically, the density in this region is assumed to be constant, and the ratio of free stream to local density is small but not negligible. The pressure coefficients near the stagnation point are calculated for blunt two-dimensional and axially symmetric bodies. These results agree with experiments and with Hayes' results within the limits of applicability of his theory. Shock detachment distances are also predicted, but with slightly less accuracy.

RPI.05:009

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

INVISCID HYPERSONIC FLOW AROUND SPHERES AND CIRCULAR CYLINDERS, by E. D. Martin. Apr. 1958, 70p. incl. diagrs. refs. (Rept. no. TR-AE-5807) (AFOSR-TN-58-448) (AF 18(600)1591) AD 158254 Unclassified

Also published in Jour. Aero/Space Sciences, v. 26: 529-530, Aug. 1959.

An approximate method is presented for calculating the flow around spheres and circular cylinders in steady hypersonic flow; the results are in terms of simple closed form analytical expressions. The method is applicable to flows in the hypersonic regime and increases in accuracy with increase in Mach number. The effects of viscosity and heat conduction in the flow outside the boundary layer in the region behind the detached shock wave are neglected. The equations of motion can then be integrated exactly if the approximation is made that the density in the shock layer is nearly constant, which is valid for sufficiently high Mach numbers. An additional approximation, that the shock wave is concentric with the body surface, was also made to simplify the application of the boundary conditions known at the shock wave. The integration of the equations of motion was accomplished by the introduction of an unknown function, which was proportional to the stream function, and a third order ordinary differential equation was obtained. The solution for the sphere is a polynomial, while the 2-dimensional solution is found in terms of Bessel functions. Some important properties of the flow that can be found from this solution are shock detachment distance, velocity, stagnation point velocity gradient, vorticity, stream function, pressure coefficient and M_1 , a parameter defined in the analysis, which may be identified and compared with Mach number. The results (except for M_1) are given completely in terms of the shock density ratio. In general the results are found to agree fairly well with those obtained in other theoretical and experimental investigations.

RPI.05:010

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

INVISCID FLOW AROUND A BLUNT BODY OF A REACTING MIXTURE OF GASES. PART A. GENERAL ANALYSIS, by W. Lick. May 1958, 52p. incl. diagrs. refs. (Rept. no. TR-AE-5810) (AFOSR-TN-58-522) (AF 18(600)1591) AD 158335; PB 136214 Unclassified

A description is presented of a general numerical procedure whereby the details of inviscid flow about a blunt body of a mixture of perfect gases, including the effects of chemical reaction and relaxation, may be calculated. The fundamental equations and boundary conditions for the inviscid, nonheat conducting flow of a mixture of perfect gases are presented. The effects of vibrational relaxation and finite dissociation and recombination rates are included. An inverse method is described whereby if the form of the detached shock wave is known or is assumed, the flow field behind the shock and the corresponding shape of the body may be found. The method of solution and an iteration procedure to increase the accuracy of the computation are discussed. A method

RPL 05:011-013; RPL 08:001

of characteristics for 2-dimensional flow is developed including effects of vibrational relaxation and finite dissociation and recombination rates; the speed of sound is also briefly discussed. A rough analysis of dissociation and recombination rates is made in order to perform numerical computations using the methods presented, and to obtain reasonable qualitative effects of finite reaction times.

ance designs significantly. The present method should provide means of accurate determination of the following quantities: (1) the rate of change of lift coefficient with angle of attack, and (2) the rate of change of moment coefficient with angle of attack; both quantities are important in stability evaluation.

RPL 05:013

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

INVISCID FLOW AROUND A BLUNT BODY OF A REACTING MIXTURE OF GASES. PART B. NUMERICAL SOLUTIONS, by W. Lick. Dec. 1958, 81p. incl. diagrs. (Rept. no. TR-AE-5814) (AFOSR-TN-58-1124) (AF 18-600)1591 AD 214724; PB 140581 Unclassified

To determine the effects of chemical non-equilibrium on the flow about a blunt body, a detailed analysis of the flow field is necessary. The present paper describes an inverse method for the computation of the subsonic shock layer region. Results for three examples for the flow of air and one for the flow of pure oxygen through a prescribed shock shape at a Mach number of 14 and for free stream density and temperature corresponding to those at 100,000 ft altitude are presented. For air, three shock radii are chosen so that they represent three classes of flows: (1) an equilibrium flow, (2) a non-equilibrium flow and (3) a chemically frozen flow. These results show appreciable effects on the flow quantities due to chemical non-equilibrium. The limitations and methods of improving the accuracy of the numerical integration are discussed. A comparison of the results with Freeman's non-equilibrium theory, other equilibrium theories and experimental results is also given. (Contractor's abstract)

RPL 08:001

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

ANALYSIS OF TWO FLOW FIELDS IN NONDISSIPATIVE INTERACTION, by V. Oskay. Jan. 1958, 42p. incl. diagrs. refs. (Rept. no. TR-AE-5711) (AFOSR-TN-58-334) (AF 18(603)37) AD 1577'6 Unclassified

Two methods of analysis are developed for the study of the interaction of two non-viscous, incompressible fluids in an energy exchange mechanism proposed by Foa (A New Method of Energy Exchange Between Flows and Some of Its Applications, Report of the Dept. Aeronaut. Engineering, Rensselaer Polytechnic Inst., Troy, New York, Dec. 1955).

RPL 05:011

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

SIMPLE SHEAR FLOW PAST A FLAT PLATE IN AN INCOMPRESSIBLE FLUID OF SMALL VISCOSITY, by T.-Y. Li. July 1958, 45p. incl. diagrs. refs. (Rept. no. TR-AE-5813) (AFOSR-TN-58-718) (AF 18(600)1591) AD 162253; PB 137905 Unclassified

Discussion is presented on the following topics: Simple shear flow past a flat plate in a fluid of small viscosity; Undisturbed free stream and order of magnitude considerations; Navier-Stokes equations and diffusion of vorticity on the boundary layer; Boundary conditions for the viscous layer; Zero approximation: Blasius' solution; First approximation: vorticity effects; Induced pressure gradient due to displacement thickness; Light-hill's source distribution method; Controversy regarding induced pressure gradient resolved; and Law of skin friction.

RPL 05:012

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

ON A POWER SERIES METHOD OF SOLUTION OF A BODY OF REVOLUTION AT AN ANGLE OF ATTACK IN HYPERSONIC INVISCID FLOW, by T.-Y. Li. Aug. 1958 [27]p. incl. diagrs. (Rept. no. TR-AE-5812) (AFOSR-TN-58-956) (AF 18(600)1591) AD 205349 Unclassified

A method of systematic solution of the aerodynamic problem of hypersonic inviscid flow past a body of revolution at a small angle of attack is presented. The equations of motion and the boundary conditions on the body surface and at the shock wave are examined. For a small angle of attack, ϵ , it is shown that the solution can be expressed as an ascending power series of ϵ . A sequence of differential equations with appropriate boundary conditions corresponding to various degrees of approximation is obtained. The approximation of the zero order corresponds to the case of the axisymmetric flow past the body of revolution. Higher order approximation equations are linear equations, the first order approximation equations are studied here. The aerodynamic stability of rocketcraft presents some unusual problems which can influence both structure and guid-

RPI.09:001-004; RPI.06:007

RPI.09:001

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

ON A BOUNDARY LAYER APPROXIMATION TECHNIQUE, by K.-T. Yen. Apr. 1, 1958, 34p. incl. refs. (Rept. no. TR-AE-5802) (AFOSR-TN-58-403) (AF 49-638)23 AD 158206 Unclassified

The problem of two-dimensional steady viscous flow is formulated using the streamlines and their orthogonal trajectories as generalized coordinates. Based on this, two boundary layer approximations are then developed. The first one, called the P-approximation, applies to boundaries with surface curvature equal to zero. This approximation is essentially equivalent to Prandtl's boundary layer theory. The second boundary layer approximation, called the C-approximation, is developed for the study of the effect of surface curvature. The conditions under which similar solutions exist for the C-approximations are obtained. Because of the complexity of the differential equations, high speed computing machines will have to be used to obtain solutions of the C-approximation. (Contractor's abstract)

RPI.09:002

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

ON THE INDETERMINATENESS OF THE BOUNDARY CONDITIONS FOR A MIXING PROBLEM, by K.-T. Yen. Dec. 30, 1957, 13p. incl. diagrs. refs. (Rept. no. TR-AE-5710) (AFOSR-TN-58-449) (AF 49-638)23 AD 200728 Unclassified

Results obtained from a study of the indeterminateness of the boundary conditions for laminar mixing of two "free" parallel streams under constant pressure is presented in this report. A method is given for the determination of the interface velocity in the mixing region, as well as the transverse force acting on the dividing wall as a consequence of the mixing. Numerical examples are given to show that values of interface velocity obtained here differ appreciably from those obtained by using other proposed boundary conditions.

RPI.09:003

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

TWO-DIMENSIONAL LAMINAR MIXING OF COMPRESSIBLE FLUID STREAMS UNDER STREAMWISE PRESSURE GRADIENT, by K. Toba. Apr. 1, 1958, 16p. incl. refs. (Rept. no. TR-AE-5804) (AFOSR-TN-58-520) [AF 49-638)23] AD 158333 Unclassified

A study of methods for solving the laminar mixing of

two-dimensional fluid streams under pressure gradient in the streamwise direction is presented. The discussion begins in Section I with the incompressible case. Compressible flows are taken up in Section II. Particular emphasis is placed on the study of the possibility of a similar solution. (Contractor's abstract)

RPI.09:004

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

STUDY OF SOME SUPERSONIC ROTATIONAL FLOW PROBLEMS BY A PERTURBATION TECHNIQUE, by C. Thyagarajan and K.-T. Yen. Apr. 1958, 37p. incl. diagrs. (Rept. no. TR-AE-5803) (AFOSR-TN-58-624) (AF 49-638)23 AD 162154; PB 138976 Unclassified

A small perturbation technique using generalized coordinates formed by streamlines and their orthogonal trajectories is applied to the analysis of some supersonic rotational inviscid flows. With a properly prescribed pressure distribution on a body surface in generalized coordinates, the body shape and the pressure field in the physical plane can be determined. Using a conveniently chosen initial Mach number distribution two examples have been studied in some detail. The first one is concerned with a linear surface pressure distribution which gives a nearly wedge-shaped body in the physical plane. It is shown that the wedge angle should be negative or positive depending on the slope of the vorticity distribution to create the pressure distribution prescribed. To examine the phase shift of the pressure distribution for a supersonic rotational flow over a periodically wavy wall, a sinusoidal pressure distribution is chosen as the second example. It is shown that the phase shift also depends on the slope of the vorticity distribution. (Contractor's abstract)

RPI.06:007

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

THE THERMODYNAMICS OF HYDROGEN CHLORIDE IN ETHYL ALCOHOL FROM ELECTROMOTIVE FORCE MEASUREMENTS, by H. Taniguchi and G. J. Jans. Nov. 1956, 1v. incl. diagrs. tables, refs. (Technical note no. 7) (AFOSR-TN-57-25) (AF 18-600)333 AD 115059 Unclassified

Also published in Jour. Phys. Chem., v. 61: 688-693, May 1957.

Electromotive force measurements of the cell without liquid junction: $\text{Pt}, \text{H}_2 (1 \text{ atm}) | \text{HCl in Ethanol (m)} |$

AgCl-Ag have been carried out at 25° over a concentration range from 0.0048 to 0.12 molal. New experimental techniques were devised and the best theoretical treatment was employed. The standard molal electrode

RPL 06:008; RPL 10:001;
RPL 11:001; RPL 12:001

potential of the silver, silver chloride electrode in anhydrous ethanol is -0.08138 volt. This value and the activity coefficients of hydrogen chloride computed from the data are recommended for the practical standardization of the silver-silver chloride electrode in anhydrous ethanol at 25°. (Contractor's abstract)

RPL 06:008

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

STANDARD ELECTRODE POTENTIALS IN NON-AQUEOUS SOLVENTS, by H. Taniguchi, S. S. Danyluk, and G. J. Janz. Final rept. Nov. 1956, 15p. (AFOSR-TR-57-4) (AF 18(600)333) AD 115060 Unclassified

The standard reference electrodes, hydrogen and silver, silver chloride, have been the subject of an exact investigation. A best procedure for the preparation of stable and reproducible electrodes for precision investigations has been developed. In acetonitrile, emf measurements with these electrodes were impossible owing to electrode instability and poisoning. The conductance of hydrogen chloride was investigated at 25°C to interpret the behavior of this solute in the light of the interionic attraction theory. In absolute ethyl alcohol the determination of the standard potential for the silver, silver chloride electrode and the thermodynamics of hydrogen chloride have been completed at 25°C. The theoretical problem of the concept of the absolute electrode potential, and the experimental attempts to measure absolute potentials have been critically examined. The problem of the relation of the electromotive force series in various non-aqueous solvents to that in water has also been discussed. A need exists for sound electrode potential data in non-aqueous media to advance the theoretical aspects of the subject. (Contractor's abstract)

RPL 10:001

Rensselaer Polytechnic Inst. [Dept. of Chemistry]
Troy, N. Y.

STUDY OF EFFECT OF DEFORMATION ON THE THERMAL EXPANSION OF METALS, by H. B. Huntington. Apr. 2, 1957, 5p. (AFOSR-TR-57-60) (AF 18(600)649) AD 136528 Unclassified

The study of the effect of deformation on the thermal expansion of metals is reviewed. The effects of steady stress on various materials (Mg, brass, Cu, and Al) were first investigated in an attempt to understand the basic causes for the phenomena. A temperature-regulated box with stations for 8 specimens was installed. Each station consisted of a long quartz tube closed at one end. The specimen is pushed against the end by pressure from a long quartz rod, and the differential motion of the ends of the tube and rod as observed well

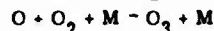
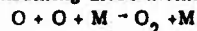
outside the box gives a measure of the thermal expansion of the specimen. Unaccountable variations in single runs and larger variation in level from one run to another were attributed to possible variations in the specimens themselves. Metallographic examination confirmed this in part, and more care was devoted to the pretreatment anneal. For Mg, a count of the twin boundary abundance correlated well with the mechanical history and could be used as a sensitive index of the completeness of the initial anneal. Methods for improving the contact between specimen and quartz rod were developed, and attention was given to reducing the temperature dependence of the part of the system which remains at room temperature.

RPL 11:001

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

UTILIZATION OF ENERGY STORED IN THE UPPER ATMOSPHERE, by P. Harteck and R. R. Reeves, Jr. Final technical rept. July 15, 1957, 61p. incl. diagrs. tables. (AFOSR-TR-57-50) (AF 18(600)1336) AD 135421 Unclassified

This work has been divided into two parts. First, an investigation to develop a flying missile, now called the HARE. The HARE is to fly through the upper atmosphere within the region where oxygen atoms are present and most dense. The HARE is to be propelled by energy obtained by recombination of these atoms on a catalytic surface placed inside. The atmosphere would be scooped in, heated, and rush out the tail, pushing the missile forward. The investigation included determination of a catalyst for the recombination, materials of construction, and various calculations indicating the feasibility of such a missile. Further equipment has been obtained to test various models of the HARE under simulated flight conditions. As a second, more recent, part of the work a study has been started to determine more precisely the maximum oxygen atom concentration in the upper atmosphere. Several reactions must be considered of importance in consuming these atoms such as



The results from experiments undertaken indicate that the rate coefficient for the second reaction involving the formation of ozone is equal to $5.7 (\pm 0.2) \times 10^{-34}$. (Contractor's abstract)

RPL 12:001

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

CONSTITUTION OF MOLTEN SALTS, by G. J. Janz.

RPL12:002 - RPL12:005

May 1957 [55]p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-57-239) (AF 49(638)50)
AD 126536 Unclassified

The constitution of molten salts is reviewed with particular interest on the contributions gained from Raman and x-ray spectroscopy and physicochemical investigations based on electrical conductance and cryoscopy. The scope is limited to the more simple inorganic salts; the structure of slags and silicates is not treated, as these systems may be regarded as macro-molecules and highly polymerized forms of molten salts. (Contractor's abstract)

RPL12:002

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

TRANSFERENCE NUMBERS IN MOLTEN SALTS, by M. R. Lorenz and G. J. Janz. May 1957, 1v. incl. diagrs. tables. (Technical note no. 2) (AFOSR-TN-57-240) (AF 49(638)50) AD 126537 Unclassified

Also published in Jour. Phys. Chem., v. 61: 1683-1684, Dec. 1957.

A detailed description of previous work on transport numbers in molten salts is presented, with special consideration given to the most recent work published in this field. The applicability of a moving indicator bubble method to molten silver chloride was studied. A transport furnace, control circuit for constant temperature, a constant current dc power supply, silver chloride purification system and electrolysis cells were designed and constructed. A transference number equation, applicable to the system investigated, was derived. A basic study was undertaken with respect to mobility, sensitivity, reversibility, reproducibility and current leakage of air indicator bubbles in aqueous and molten salt media. It follows that the experimental methods based on air indicator bubbles or electrode displacements, described in the most recent studies of lead chloride, cannot be applied to determine the transport numbers of silver chloride. Analysis of the experimental and theoretical problems of the properties of molten inorganic salts has led to criteria for evaluation of results reported in this field. The great discrepancy in the values for the transport number of the lead ions in molten lead chloride is resolved in the light of the present investigation. (Contractor's abstract)

RPL12:003

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

A RECORDING BECKMAN THERMOMETER AND DIFFERENTIAL POTENTIOMETER, by C. Solomons and

G. J. Janz. Aug. 1957, 6p. diagrs. (Technical note no. 3) (AFOSR-TN-57-497) (AF 49(638)50) AD 136487
Unclassified

An apparatus is described by means of which accurate measurements and records of changing electromotive forces can be made. The apparatus is normally used to measure and record changes of temperature of 1 to 5°C. The principle of operation is such that small differences in emf between a test source such as a thermocouple and a standard source such as a potentiometer is amplified by means of a stable dc microvolt amplifier. A continuous-balance stripchart potentiometer recorder is used with the device.

RPL12:004

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

A CRYOSOPIC ASSEMBLY FOR PRECISE MEASUREMENTS UNDER CONTROLLED ATMOSPHERES AT TEMPERATURES UP TO 500°C, by C. Solomons and G. J. Janz. Aug. 1957 [12]p. incl. diagrs. tables. (Technical note no. 4) (AFOSR-TN-57-526) (AF 49(638)50) AD 136510 Unclassified

Also published in Rev. Scient. Instruments, v. 29: 302-304, Apr. 1958.

A cryoscope is described which was designed for the accurate measurement of freezing points of molten salts under controlled atmospheres. It possesses several advantages over apparatus in the published literature, especially when used with solutions which attack or embrittle the glass container. The ancillary apparatus used with the cryoscope is also described, and the features of the apparatus are discussed. Examples are given to show how several problems of molten salt cryoscopy under controlled atmospheres have been satisfactorily overcome. (Contractor's abstract)

RPL12:005

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

A CALORIMETRIC ASSEMBLY FOR THE MEASUREMENT OF HEATS OF FUSION OF INORGANIC COMPOUNDS, by J. Goodkin, C. Solomons, and G. J. Janz. Sept. 1957 [15]p. incl. diagrs. table, refs. (Technical note no. 5) (AFOSR-TN-57-565) (AF 49(638)50) AD 136548 Unclassified

Also published in Rev. Scient. Instruments, v. 29: 105-108, Feb. 1958.

A calorimetric assembly is described which was designed for the measurement of heats of fusion of inorganic compounds by the method of mixtures. When used

RPL12:006 - RPL12:010

with the calibration technique described it is capable of an accuracy of about $\pm 2\%$. The simplicity of design and the manner in which the apparatus minimizes or avoids many errors possible in high-temperature calorimetry is discussed. (Contractor's abstract)

RPL12:006

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

EVALUATION OF THE INDICATOR BUBBLE AND ELECTRODE DISPLACEMENT METHODS FOR TRANSPORT NUMBER MEASUREMENTS IN MOLTEN SALTS, by M. R. Lorenz and G. J. Janz. [1957] [2]p. incl. tables. (AF 49(638)50) Unclassified

Published in Jour. Phys. Chem., v. 61: 1683-1684,
Dec. 1957.

The factors important in the application of these two methods were analyzed, and published experimental results with molten $PbCl_2$ and $AgCl$ were evaluated.

Although the electrode displacement appears to be sound in theory, the technique leads to erroneous results unless the molten metal/gas interface is such that the molten metal shows no tendency toward "stickiness" in the transport cell.

RPL12:007

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

PHYSICAL PROPERTIES AND CONSTITUTION OF MOLTEN SALTS. ELECTRICAL CONDUCTANCE, TRANSPORT, AND CRYOSCOPY, by C. Solomons and G. J. Janz. Dec. 1957, iv. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-58-17) (AF 49(638)50) AD 148056 Unclassified

Also published in Chem. Rev., v. 58: 461-508, June 1958.

A review is presented of the literature on the theories and experimental techniques of electrical conductance, electrical transport, and cryoscopy of molten salt systems, with particular consideration given to problems of structure and constitution. There are 278 foreign and domestic references cited, both published and unpublished, covering a period from 1833 to 1957.

RPL12:008

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

PREPARATION AND THERMAL STABILITY OF LITHIUM TITANIUM FLUORIDE, by M. R. Lorenz and

G. J. Janz. Feb. 1958 [17]p. incl. diagrs. tables. (Technical note no. 7) (AFOSR-TN-58-150) (AF 49(638)50) AD 152207 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 4126-4128, Aug. 20, 1958.

The preparation of Li_2TiF_6 (93.8% purity, 76% yield) is described, and the x-ray data on lattice spacings is given. The thermal stability of the compound in vacuum at temperatures up to $485^\circ C$ is investigated, and the primary dissociation to LiF and TiF_4 is confirmed by means of a sample which dissociated 42.5% when held at $485^\circ C$ for 21 hours. It is found that Li_2TiF_6 undergoes hydrolysis when heated in air with the reaction products identified as TiO_2 , LiF , and HF . (Contractor's abstract, modified)

RPL12:009

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

CRYOSCOPY AND CONSTITUTION OF MOLTEN SALT MIXTURES IN THE LITHIUM CHLORIDE-POTASSIUM CHLORIDE EUTECTIC AND MERCURIC BROMIDE, by J. Goodkin and G. J. Janz. Aug. 18, 1958, iv. incl. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-58-736) (AF 49(638)50) AD 162269; PB 151171 Unclassified

A calorimeter was developed which was capable of measuring heats of fusion of inorganic salts to an accuracy of $\pm 2\%$. The heats and entropies of fusion and the cryoscopic constant were determined for the $LiCl$ - KCl eutectic mixture, $AgNO_3$, and $HgBr_2$. The values were $3200 \pm 60 \text{ cal mol}^{-1}$, 5.1 EU, and $13.6 \text{ deg mol}^{-1}$ 1000 g^{-1} for the mixture; $2890 \pm 60 \text{ cal mol}^{-1}$, 5.9 EU and $27.2 \text{ deg mol}^{-1}$ 1000 g^{-1} for $AgNO_3$; and $4280 \pm 80 \text{ cal mol}^{-1}$, 8.4 EU, and $43.8 \text{ deg mol}^{-1}$ 1000 g^{-1} for Hg_2Br_2 . The cryoscopy of the alkali halides in the $LiCl$ - KCl eutectic mixture was extended to include LiF and KF solutes. The Temkin model adequately described the properties of $NaCl$, NaF , and KF in the chloride eutectic.

RPL12:010

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

BIBLIOGRAPHY ON MOLTEN SALTS, by C. T. Brown, H. J. Gardner and others. Sept. 1958, 73p. (Technical note no. 9) (AFOSR-TN-58-773) (AF 49(638)50) AD 201776; PB 151429 Unclassified

RPL13:001 - RPL13:004

The bibliography is based on a survey of the information published up to 1958 in the technical press on the subject of molten salts. The references have been classified for the bibliography under the following headings: apparatus and techniques, cryoscopy, diffusion and electromigration, electrical conductance, electrode processes, reviews, liquid structure, phase equilibria, physical properties, process of fusion, solutions of metals, spectroscopy and bonding, thermochemistry, and thermodynamics. Each contribution is listed by author, journal, and title of the article. There are approximately 1000 entries.

RPL13:001

Rensselaer Polytechnic Inst. [Dept. of Chemistry]
Troy, N. Y.

THERMAL ASPECTS OF GALLING OF DRY METALLIC SURFACES IN SLIDING CONTACT, by F. F. Ling and E. Saibel. [1957] [12]p. incl. diagrs. table, refs. (Sponsored jointly by [Air Force Office of Scientific Research under AF 49(638)67] and Office of Ordnance Research) Unclassified

Published in Wear, v. 1: 80-91, Oct. 1957.

The phenomenon of galling or seizing of metals is believed to be, in general, a function of the thermal and mechanical conditions under which the metallic surfaces are rubbed together. For polished surfaces, under ideal dynamic conditions, i.e., conditions where the surfaces are devoid of appreciable oscillations in the direction normal to the surfaces, thermal aspects of galling predominate. Galling due to thermal conditions is viewed as that condition where the tips of surface asperities weld together and are then sheared apart according to the weld-junction or adhesion theories. Welding may be achieved when the melting temperature is reached; also when surface asperities, which are under a high degree of strain, are in sliding contact. Welding may be achieved by recrystallization recovery. The latter process is taken as the governing condition for thermal galling since the recrystallization temperature is only a fraction of the melting temperature. The galling criterion, relating normal load, velocity, and time of rubbing, is established theoretically. The result compares favorably with experience. (Contractor's abstract)

RPL13:002

Rensselaer Polytechnic Inst. [Dept. of Chemistry]
Troy, N. Y.

ON KINETIC FRICTION BETWEEN UNLUBRICATED METALLIC SURFACES, by F. F. Ling and E. Saibel. [1957] [6]p. incl. diagrs. (Sponsored jointly by [Air Force Office of Scientific Research under AF 49(638)-67] and Office of Ordnance Research) Unclassified

Published in Wear, v. 1: 167-172, Dec. 1957.

A theory of friction between unlubricated metallic surfaces in sliding contact is proposed. For sliding conditions for which "hot" or "cold" welding of asperities is possible, the present weld-junction theory leads to a simple formulation of the coefficient of friction under idealized conditions. This result differs from that of Bowden and Tabor in that the coefficient of friction is found as the ratio of the shear strength to the yield pressure multiplied by a factor in which additional effects of load, relative velocity, temperature, and other physical properties appear. In arriving at this factor, the process of welding and fracturing of surface asperities is postulated to be a unimolecular reaction. (Contractor's abstract)

RPL13:003

Rensselaer Polytechnic Inst. Dept. of Chemistry,
Troy, N. Y.

ASPERITY DISTRIBUTIONS OF METALLIC SURFACES, by F. F. Ling. Jan. 20, 1958, 1v. incl. diagrs. refs. (Technical note no. 1) (AFOSR-TN-58-77) (AF 49(638)-67) AD 148125 Unclassified

Also published in Jour. Appl. Phys., v. 29: 1168-1174, Aug. 1958.

The load-compliance characteristics of eight models characterizing eight combinations of the shape and the distribution of the asperities are graphically presented and the inadequacies of these models are pointed out. A more elaborate distribution is proposed, and a deformation process is postulated. This new model is used to interpret the results of load and compliance measurements in a satisfactory manner.

RPL13:004

Rensselaer Polytechnic Inst. [Dept. of Chemistry]
Troy, N. Y.

ADHESION, "PURE-SHEAR" AND FRICTION MEASUREMENTS AND WELDING ASPECT OF FRICTION, by F. F. Ling. Jan. 30, 1958 [29]p. incl. illus. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-58-281) (AF 49(638)-67) AD 154183; PB 133966 Unclassified

This paper proposes a mechanism of recrystallization recovery for the welding mode of adhesion in contradistinction to the surface-tension mode of adhesion. Qualitatively, the resulting formulation is supported by data of Bowden and Rowe (Proc. Roy. Soc. (London), v. 233A: 429, 1956). Also, a new relationship is proposed between adhesion, "pure-shear" and friction. "Pure-shear" refers to the shear force required to cause sliding after normal load is removed. It is believed that the relationship further elucidates the role welding plays in

RPI. 13:005, 006; RPI. 14:001, 002

the friction process. Moreover, measurements of adhesion, "pure-shear" and friction on lead specimens in limited quantity seem to substantiate the proposed theory. (Contractor's abstract)

RPI.13:005

Rensselaer Polytechnic Inst. [Dept. of Chemistry]
Troy, N. Y.

A QUASI-ITERATIVE METHOD FOR COMPUTING INTERFACE TEMPERATURE DISTRIBUTIONS, by F. F. Ling. Oct. 1958, 22p. incl. diagr. (Technical note no. 3) (AFOSR-TN-58-1004) (AF 49(638)67) AD 206147 Unclassified

Also published in Zeitschr. Angew. Math. Phys., v. 10: 461-474, Sept. 1959.

A simple model of sliding contact is proposed for the experimentalist who is interested in the wear distribution, which is dependent on the temperature distribution of the interface. A relative simple method is developed for calculating the interface temperature distribution for the proposed model. The method is iterative in nature; the quasi-iterative method developed here reduces drastically the number of quasi-iterations to no more than one in most cases. An example is given to illustrate this point. The method may be extended to more complex models. Although the present method is iterative in nature, the actual labor involved is less than that required for numerical solution of the problem given a degree of computational accuracy. Results show that the interface temperature model can be used as an analogue problem for inverting a class of singular integral equations of the first kind. (Contractor's abstract)

RPI.13:006

Rensselaer Polytechnic Inst. [Dept. of Chemistry]
Troy, N. Y.

ON MODEL STUDIES OF METALLIC SURFACE ASPERITIES, by F. F. Ling and R. C. Lucek. Dec. 1958, [26]p. incl. illus. diagrs. table, refs. (Technical note no. 4) (AFOSR-TN-58-1134) (AF 49(638)67) AD 208083; PB 138734 Unclassified

Also published in Jour. Appl. Phys., v. 30: 1559-1563, Oct. 1959.

An apparatus for measuring two components of the force generated at the tips of two cones throughout the sliding-contact life-cycle is described. The cones are used to simulate a class of surface asperities. Test results under atmospheric conditions show: (1) That for cones with 90° internal angles the ratio of the integrated value of the horizontal component over the length of the life-cycle to that of the vertical component, a measure of coefficient of friction after Green [Proc. Royal Soc.

(London) v. 228A: 191-204, Feb. 22, 1955], is not sensitive to the presence of lubricants for the case where the cone tips are in line or nearly in line with the direction of relative motion, direct-hit modes. But the ratio is substantially lowered in the presence of lubricants when the cone tips are far from in line with the direction of relative motion, slide-swipe modes. Direct-hit modes are always accompanied by the formation of macroscopic wear debris while side-swipe modes are usually not accompanied by an macroscopic debris; and (2) That by increasing the internal angle of cones, the ratio defined above is decreased, but its value does not seem to approach 0 for the angle approaching 180°. On the basis of the above, the mutual inclusiveness of the classical interlock theory and the popular adhesion theory of friction is discussed. Moreover, the coefficient of friction for a pair of idealized surfaces with asperities in the form of 90° cones and randomly distributed is calculated from considerable amount of test data. (Contractor's abstract)

RPI.14:001

Rensselaer Polytechnic Inst. Dept. of Geology, Troy, N. Y.

A PRINCIPLE OF VIRTUAL DISPLACEMENTS FOR REAL FLUIDS, by P. Lieber, K.-S. Wan, and O. Anderson. July 1957, 21p. incl. diagrs. tables. (AFOSR-TN-57-476) (AF 18(600)1704) AD 136488 Unclassified

Also published in Proc. Ninth Internat'l. Congress of Appl. Mech., Brussels (Belgium) (Sept. 5-13, 1956), v. 1: 106-113, 1957.

A principle of virtual displacements for incompressible viscous flows is formulated with the Navier-Stokes equations rendered as the Euler equations for the generating function. This variational principle asserts that the work done by the forces applied to an arbitrary surface at which the velocities are assigned, is stationary for the real motion or path. As in the case of the principle of virtual displacements in mechanics, only the displacements are subjected to the variation and the forces are kept constant under the variation. The principle is applied to the calculation of the skin friction coefficient, velocity profile, and thickness of rotational regime for a flat plate under the restrictions of the boundary layer theory. The results are in good agreement with the Blasius solution and experimental data.

RPI.14:002

Rensselaer Polytechnic Inst. Dept. of Geology, Troy, N. Y.

A PRINCIPLE OF MINIMUM DISSIPATION FOR REAL FLUIDS, by P. Lieber and K.-S. Wan. Aug. 1957, 52p. incl. diagrs. tables. (AFOSR-TN-57-477) (AF 18(600)-1704) AD 136469 Unclassified

RPI.14:003 - RPI.14:006

Also published in Proc. Ninth Internat'l. Congress of Appl. Mech., Brussels (Belgium) (Sept. 5-13, 1956), v. 1: 114-126, 1957.

The principle of minimum dissipation is introduced as a hypothesis which asserts that consistent with the constraints imposed by the conservation laws and boundary conditions, the observable flow patterns minimize the time rate of dissipation of energy. The principle is applied to 2-dimensional incompressible viscous flows to establish that the admissible flow patterns are governed by the biharmonic equation for the stream function which satisfies the continuity equation. The necessary and sufficient general conditions, under which flows admissible by this variational principle are also admissible by the Navier-Stokes equation, are established for incompressible viscous flows. This requirement gives an auxiliary differential equation governing the transport and distribution of vorticity which is interpreted to show that flows which are everywhere time-independent can occur only under special conditions. This principle is applied to a circular cylinder and a flat plate, and between 2 parallel flat plates.

RPI.14:003

Rensselaer Polytechnic Inst. Dept. of Geology, Troy, N. Y.

ON A STATISTICAL THEORY FOR ONE-DIMENSIONAL REAL GAS FLOWS, by P. Lieber and K.-S. Wan. Sept. 1957, 23p. incl. diagr. (AFOSR-TN-57-478) (AF 18-(600)1704) AD 136470 Unclassified

A set of mathematically tractable governing conditions are obtained for compressible-viscous flows. The equations are formulated in terms of physical parameters which describe the behavior of a gas in its most primitive and yet essential aspects. The parameters are the mass density, the mass flow velocity, and the root mean square of the velocity fluctuations relative to the mean velocity. A characteristic length is introduced which represents the mean free path. The flow field is regarded as made up of discrete regions, and the state in each region, relevant from a gas-dynamic point of view, is assumed to be well represented by the parameters. The theory yields a relation across a normal shock wave which is in agreement with the Rankine-Hugoniot theory. The developed theory shows that downstream flow conditions depend upon the disturbance as well as upon the inflow Mach number. The expansion compression wave may, according to the theory, be produced in an initially subsonic flow when the disturbance has a critical range determined by the Mach number. The relationship of this theory to the Navier-Stokes theory is discussed.

RPI.14:004

Rensselaer Polytechnic Inst. Dept. of Geology, Troy, N. Y.

A PROOF AND GENERALIZATION OF THE PRINCIPLE OF MINIMUM DISSIPATION, by P. Lieber and K.-S. Wan. Sept. 1957 [20]p. (AFOSR-TN-57-479) (AF 18-(600)1704) AD 136471 Unclassified

The principle of stationary dissipation and the L variational principle for real fluids are used to calculate the flow fields produced under various boundary conditions. The modified Couette flow is considered and extended to include the free surface problem. The L principle is used to obtain both the temporal mean and time-dependent flow for the Couette case and for the modified Couette flow. The preliminary results indicate the possibility of obtaining real vortices when the L principle is employed to calculate flows about closed bodies. The curvature at the boundary appears to be fundamental in the production of real vortices.

RPI.14:005

Rensselaer Polytechnic Inst. Dept. of Geology, Troy, N. Y.

A STUDY LEADING TO THE BOUNDARY CONDITIONS AT A FREE SURFACE JOINING AN IRRATIONAL-ROTATIONAL FLOW REGIME, by P. Lieber and K.-S. Wan. Sept. 1957 [11]p. incl. diagr. (AFOSR-TN-57-480) (AF 18(600)1704) AD 136472 Unclassified

A theoretical demonstration is given that the curvature of the interface is necessary, as a consequence of the boundary conditions assigned at the interface, for terminating the rotational regime. Therefore, the mechanisms which terminate the rotational regime are related to the mechanism which produces the curvature called for at the interface. In investigating these mechanisms, a number of elementary flow configurations calculated according to the principle of stationary dissipation are considered. The problem of a two-dimensional viscous incompressible flow produced by a circular cylinder is investigated in three stages. The first consists of obtaining a solution to the classical problem treated by Stokes; the second encloses the cylinder by two fixed boundaries and calculates the resulting flow; the third frees the portions of the boundaries arbitrarily fixed in the second stage.

RPI.14:006

Rensselaer Polytechnic Inst. Dept. of Geology, Troy, N. Y.

APPLICATIONS BASED ON VARIATIONAL PRINCIPLES FOR REAL FLUIDS, by K.-S. Wan and P. Lieber. Sept. 1957 [36]p. incl. diagrs. (AFOSR-TN-57-481) (AF 18-(600)1704) AD 136473 Unclassified

Application was used of the "L" principle to the

RPI.14:007; RPI.07:004-007

calculation of a real flow field about a circular cylinder in a manner which will include the determination of the extent of the rotational regime. The differential equation governing the time dependent steady state motion according to the "L" principle and the compatibility condition is investigated. This investigation relates the temporal mean flow to the temporal fluctuations. It thereby suggests a connection with turbulent flow. The coupling of the time dependent motion and the temporal mean flow suggests the possibility of calculating inhomogeneous turbulent flows from this point of view.

RPI.14:007

[Rensselaer Polytechnic Inst. Dept. of Geology, Troy, N. Y.]

[VARIATIONAL PRINCIPLES FOR CALCULATION OF REAL FLOWS] by K.-S. Wan. Final rept. [1958] 6p. (AFOSR-TN-58-23) (AF 18(600)1704) AD 152186
Unclassified

Summaries are presented of the following research activities conducted under this contract: Principle of virtual displacements for real fluids; Principle of minimum dissipation; Proof and generalization of the principle of minimum dissipation; Application based on variational principles for real fluids; Boundary conditions at a free surface joining an irrotational-rotational flow regime; and Statistical theory for 1-dimensional real gas flows. All of the above studies have culminated in technical notes and have been abstracted separately. (See item nos. RPI.14:001-006.)

RPI.07:004

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

VIBRATIONS OF TWISTED BEAMS II, by W. Boyce and G. Handelman. Dec. 19, 1957 [25]p. incl. diagr. (Math rept. no. 11) (AFOSR-TN-57-773) (AF 18(600)1586) AD 148003
Unclassified

Also published in Quart. Appl. Math., v. 16: 385-395, Jan. 1959.

An assortment of qualitative properties of the energy form for the transverse vibrations of a twisted beam rotating about an axis is discussed. (Math. Rev. abstract)

RPI.07:005

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

COUPLED TORSIONAL AND LONGITUDINAL VIBRATIONS OF A THIN PRISMATIC BAR, by R. C. DiPrima.

Feb. 27, 1958 [11]p. incl. diagrs. (Math. rept. no. 12) (AFOSR-TN-58-126) (AF 18(600)1586) AD 152153
Unclassified

Also published in Jour. Appl. Mech., v. 26: 510-512, Dec. 1959.

The effect of pretwist on the natural frequencies of coupled torsional-longitudinal oscillations of thin bars is studied. It is found that the natural frequencies of oscillations which consist primarily of torsional motion may be considerably increased depending upon the thinness of the bar and upon the amount of pretwist. The natural frequencies of oscillations which consist primarily of longitudinal motion are not significantly altered. (Contractor's abstract)

RPI.07:006

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

VIBRATIONS OF A UNIFORM, ROTATING BEAM WITH TIP MASS, by G. Handelman, W. Boyce, and H. Cohen. Mar. 24, 1958 [19]p. incl. diagrs. (Math rept. no. 13) (AFOSR-TN-58-173) (AF 18(600)1586) AD 152204
Unclassified

Also published in Proc. Third U. S. Nat'l. Congress of Appl. Mech., Brown U., Providence, R. I. (June 11-14, 1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 175-180.

The effect of an added tip mass on the transverse vibrations of a uniform, cantilevered beam rotating with constant velocity about an axis through the clamped end is considered. Upper and lower bounds are established for the lowest frequency as a consequence of the minimum principle. It is shown that the tip mass tends to decrease the frequency as compared with the beam with free end. The first term in the asymptotic development for high modes is obtained. (Contractor's abstract)

RPI.07:007

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

A PLANE STRESS PROBLEM IN PIECEWISE LINEAR PLASTICITY, by W. E. Boyce. Aug. 1, 1958 [24]p. incl. diagrs. (Math. rept. no. 16) (AFOSR-TN-58-629) (AF 18(600)1586) AD 162159
Unclassified

Also published in Jour. Mech. Phys. Solids, v. 7: 114-125, 1959.

Certain plane stress problems in piecewise linear strain-hardening plasticity can be considered either directly on the basis of a two-dimensional model, or as a special case of a more general theory. Isotropic

RPI 15:001, 002; RPI 16:001;
RIA. 01:001

theories yield the same results regardless of which approach is adopted, but anisotropic theories, such as those using Prager's kinematic hardening law, may not. This paper treats a specific plane stress problem, the bending of a rigid-plastic simply-supported circular plate by a uniform load, from a three-dimensional point of view, using Prager's hardening law. This more elaborate theory predicts displacements less than half as large as those obtained for the same loads from the two-dimensional theory. The dependence of the post-yield stresses and displacements on the magnitude of the initial yield stress is also examined. (Contractor's abstract)

RPI.15:001

Rensselaer Polytechnic Inst. Dept. of Mechanics,
Troy, N. Y.

AN IMPACT TESTING MACHINE FOR PLASTICS AND RUBBER-LIKE MATERIALS, by E. Volterra and C. S. Barton. [June 1957] 14p. illus. diagrs. tables. (AFOSR-TN-57-347) (Sponsored jointly by Office of Naval Research under Nonr-59105 and Air Force Office of Scientific Research under AF 49(638)19) AD 132420
Unclassified

A testing machine for studying dynamic properties of plastics and rubber-like materials under impact loadings is described. The cylindrical specimens to be tested are placed on the plane end of a short steel bar hung as a ballistic pendulum. Another bar, also hung as a ballistic pendulum, is made to impinge upon the specimen. The force acting on the specimen during the time of impact is measured by an accelerometer fixed to the impacted bar. From the acceleration-time diagram, which is recorded on an oscilloscope, the force acting on the specimen during impact is measured. The length of the specimen during impact is determined by integrating twice the acceleration-time diagram. This accelerometer method represents a considerable improvement in experimental accuracy as compared with the optical method (drum camera method), which has been described in a previous paper, and in which method the dynamic parameters of the specimen were obtained by photographing the distance between the two bars during impact. Experiments conducted using this accelerometer method under different conditions of temperatures and impact loadings are described and the results compared with those obtained by the drum camera method. (Contractor's abstract)

RPI. 15:002

Rensselaer Polytechnic Inst. [Dept. of Mechanics]
Troy, N. Y.

THEORETICAL AND EXPERIMENTAL ASPECTS OF IMPACT PROBLEMS, by C. S. Barton. Final rept.

Sept. 5, 1957, 1v. incl. illus. diagrs. tables, refs.
(AFOSR-TR-57-84) (AF 49(638)19) AD 136674

Unclassified

An experimental attempt was made to prove the Hertz theory of impact as applied to the impact of a hemispherical end of a short rod against the plane end of an infinitely long rod. Modern instrumentation and electric strain gages mounted on the long bar and on the short bar enabled the study to be made of the time of contact (pulse length) and the stress as a function of time. The principle of the conservation of momentum of the bars was used as a basis for evaluating the accuracy of the experimental as well as the theoretical pulses. Little difference was noted in magnitude of stress, peak time, and pulse length for all bar lengths and impact velocities between the round end and flat end bars. The shapes of the experimental and theoretical curves compared favorably in the pulse rise and fall regions. Large differences exist between the theoretical and experimental pulses except in the case of the long impacting bars. The fact that a limiting value of stress was almost reached when the longer impacting bars were used also permitted good agreement in the peak time values between the theoretical and experimental pulses. Results indicated that the Hertz theory of impact as applied in the theoretical approach expressed the loading phenomena fairly well but failed to do so as soon as the pulse returned to the contact end.

RPI.16:001

Rensselaer Polytechnic Inst. Dept. of Mechanics,
Troy, N. Y.

NON-HOMOGENEOUS ELASTICITY, by M. A. Sadowsky and M. A. Goldberg. Nov. 1958, 1v. incl. diagrs. (AFOSR-TR-58-156) (AF 49(638)202) AD 162280; PB 137778
Unclassified

The following topics are included: table of notations; relations between coefficients of elasticity; orientational introduction; the problem of non-homogeneous elasticity in its general insoluble formulation; the principle of selective specializations leading to soluble cases; the generalized forms of the potential and bipotential equations; results for $\mu = \text{constant}$ and non-homogeneous elastic body in which the stress function equation in plane strain or plane stress remains $\Delta^4 \psi = 0$ or acquires additional linear terms with constant coefficients.

RIA.01:001

RIAS, Inc., Baltimore, Md.

THE STRUCTURE OF SEMI-SIMPLE LIE ALGEBRAS, by M. Hausner and S. Sternberg. 1958, 62p. (Technical rept. no. 58-9) (AFOSR-TN-58-862) (AF 49(638)382) AD 203673; PB 140141
Unclassified

RIC.01:003; RIC.02:001, 002;
ROC.06:001

The Cartan-Killing structure results for semi-simple Lie algebras in a self-contained manner are given. The presentation is meant to give an introduction to the subject by the development of the theory through the statements of theorems and lemmas, and subsequent proofs.

RIC.01:003

Rice Inst. Dept. of Mathematics, Houston, Tex.

CONTINUITY PROPERTIES OF DERIVATIVES OF SEQUENCES OF FUNCTIONS, by G. R. MacLane. [1957] [2]p. (AF 18(600)1135) Unclassified

Published in Proc. Amer. Math. Soc., v. 8: 897-898, Oct. 1957.

A supplement to Dvoretzky's generalization of a theorem of Walsh [Proc. Amer. Math. Soc., v. 7: 363-386, 1958] is presented here. The theorem states: There exists

a sequence of functions $\{f_n\}_1^\infty$, $f_n \in C^1(-\infty, \infty)$, with

$\lim_{n \rightarrow \infty} f_n(x) = 0$, such that: if N_1 is any subsequence of the natural numbers with the property that there exists a sequence x_{n_1} , $n_1 \in N_1$, satisfying

$$f'_{n_1}(x_{n_1}) = 0, \text{ and } \lim_{n_1 \rightarrow \infty} x_{n_1} = 0,$$

then the sequence N_2 complementary to N_1 (i.e., N_2 contains exactly those natural numbers omitted by N_1) is infinite and

$$\limsup_{n_2 \rightarrow \infty} \int_0^h |f'_{n_2}(x)| dx = \infty$$

for every $h > 0$.

RIC.02:001

Rice Inst. [Dept. of Mechanical Engineering] Houston, Tex.

EFFECT OF VIBRATIONS ON THE YIELD STRENGTH OF A LOW-CARBON STEEL, by G. E. Nevill, Jr. and F. R. Brotzen. Apr. 15, 1957, 12p. illus. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TN-57-170) (AF 49(638)78) AD 126463; PB 131260 Unclassified

Also published in Proc. Amer. Soc. for Testing Materials, v. 57: 751-758, 1957.

Experimental results show that, when a specimen is subjected to vibration in the frequency range from 15 kc to 80 kc, the steady stress necessary to cause plastic deformation is appreciably reduced. This reduction is examined under different conditions of vibrational

amplitude, frequency, strain, and temperature. It is found to be proportional to the vibrational amplitude, but independent to the frequency of vibration, prior strain, and temperature. Several possible explanations for this decrease in yield strength have been considered on the basis of dislocation theory. A discussion and a detailed picture of the responsible mechanisms are included. (Contractor's abstract, modified)

RIC.02:002

Rice Inst. [Dept. of Mechanical Engineering] Houston, Tex.

THE EFFECT OF VIBRATIONS ON ORDERING IN A COPPER-GOLD ALLOY, by H. C. Burghard, Jr. and F. R. Brotzen. Oct. 1, 1958 [28]p. incl. diagrs. table, refs. (Technical rept. no. 2) (AFOSR-TN-58-915) (AF 49(638)78) AD 204584 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 215: 863-868, Oct. 1959.

Experiments were performed to determine the effects of mechanical vibrations on ordering in CuAu. The effects of 5, 10 and 15 kc vibrations were investigated over a range of ordering temperatures of 280° to 380°C. A decrease in the rate of ordering was observed at all frequencies and ordering temperatures. This retarding effect is attributed to the interference of moving dislocations with growth of ordered domains. (Contractor's abstract)

ROC.06:001

Rochester U. Dept. of Chemical Engineering, N. Y.

ADHESION OF PROTECTIVE COATINGS TO METALS BY TENSILE TESTS, by G.-J. Su, T. R. Faucett, and B. Gumowski. July 1957, 75p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-496) (AF 18(600)1187) AD 136488 Unclassified

In this study, tensile tests were made with butt joints, using Al, brass, and steel as the metal substrates, and various coating formulations and commercial resins, e.g., Shell YU180, Pitt Chem 622, Clear, Gelva S55, Unichrome Primer AP10, Pliobond 20, etc. The following factors affecting adhesion are considered: (1) effect of loading rate on measured bond strength; (2) surface-treatment effects on coating adhesion to Al; (3) bond strength as a function of bond thickness; and (4) bond strength as a function of curing time for thermo-setting coatings, e.g., Shell YU180. The results of the tests are discussed in detail.

ROC.01:013; ROC.02:006-009

ROC.01:013

Rochester U. Dept. of Chemistry, N. Y.

FUNDAMENTAL INVESTIGATIONS IN THE CHEMISTRY OF ORGANIC SULFUR COMPOUNDS, by D. S. Tarbell. Final rept. Dec. 1, 1952-Dec. 1, 1955. Feb. 1957, 4p. (AFOSR-TR-57-15) (AF 18(600)482) AD 120431
Unclassified

This report summarizes the work done under this contract on the following problems: kinetics of basic hydrolysis of some lactones, hydrogen bonding involving the thiol group, the rearrangement of diaryl thion-carbonates to diaryl thiolcarbonates, free radical substitution in 3,4-benzpyrene, the action of base on alkyl allyl sulfides, and studies on thioesters related to coenzyme A.

ROC.02:006

Rochester U. Dept. of Chemistry, N. Y.

REACTION BETWEEN METHANOL AND BORON CONTAINING GLASSES, by R. P. Porter. May 27, 1957, 2p. (AFOSR-TN-57-262) (AF 18(600)1528) AD 126560
Unclassified

Also published in Jour. Phys. Chem., v. 61: 1260, Sept. 1957.

The presence of B in methanol stored in Pyrex was verified by measuring the emission caused by B at 548 m μ with a model D. U. Beckman spectrophotometer and its flame photometer attachment. The presence of trimethyl borate was verified by means of the consolidated mass spectrometer model 21-620. The mass spectrogram of a sample of anhydrous methanol which had been in contact with Pyrex was in agreement with that obtained from a sample of trimethyl borate obtained from the Pacific Coast Borax Company, purified by distillation, and that obtained from a sample of methanol in which boric acid was dissolved. The comparison of mass spectrograms was made on the basis of 18 peaks whose ratios of mass to charge are greater than the largest ratio caused by methanol. The most prominent peaks lie at 104, 103, 73, 72, and 43. The flame photometer showed that alcohol stored for several months in soft glass bottles contained 0.01 mol-% B while that stored in Pyrex contained 0.04 mol-%. The mass spectrometer showed that methyl alcohol distilled over Na in a Pyrex distilling flask contained as much as 1 mol-% of trimethyl borate. Anhydrous methanol vapor in contact with Pyrex produced varying amounts of trimethyl borate. The concentration reached as high as 12 mol-% in the course of 10 hr. When such alcohol was photolyzed with a H discharge tube, varying amounts of products were formed. Mass spectrograms of a sample of methanol which contained trimethyl borate to which small amounts of water were added showed that as the water content increased, the trimethyl borate content decreased.

ROC.02:007

Rochester U. [Dept. of Chemistry] N. Y.

THE LIQUID PHASE PHOTOLYSIS OF DIETHYL KETONE AND METHYL ETHYL KETONE, by P. Ausloos. June 15, 1957, 18p. Incl. diagrs. tables, refs. (AFOSR-TN-57-320) (AF 18(600)1528) AD 132391; PB 132306
Unclassified

Also published in Canad. Jour. Chem., v. 36: 400-409, Feb. 1958.

The liquid phase photolysis of diethyl ketone has been studied in the temperature range from -35 to 95°C. The CO quantum yield at 95°C was found to be close to unity. At 28°C decrease in intensity and addition of heptane led to a substantial increase of the CO and the ethane yield. The methyl and ethyl ketone liquid phase photolysis at temperatures between 5 and 75°C led to the same observations. Arrhenius plots of $R_E/R_B^{1/2}$ (K) gave for both compounds a value of 5 kcal/mole. Gas phase studies in the temperature range 0 to 60°C confirmed the low CO quantum yield reported previously and showed evidence for disproportionation and recombination reactions between ethyl and propionyl radicals. (Contractor's abstract)

ROC.02:008

Rochester U. [Dept. of Chemistry] N. Y.

REACTIVITIES OF ELECTRONICALLY-EXCITED KETONE MOLECULES, by J. Heicklen and W. A. Noyes, Jr. June 20, 1957, 10p. Incl. refs. (AFOSR-TN-57-342) (AF 18(600)1528) AD 132415
Unclassified

A review was made of the reactions of excited ketone molecules, with Me₂CO, biacetyl, and Et₂CO as examples. Mention was made of the methods of dissociation of the molecules and the importance of knowing the 2 quantities α , the fraction of initially excited molecules which dissociate and ϕ , the primary quantum yield. Me₂CO, biacetyl, Et₂CO, and ketone were studied in the consideration of the fraction of ϕ which is due to α . For all of them, the over-all quantum yield (and probably the primary quantum yield) increases with temperature although the effect with Et₂CO is small. The effects of added O in this study were also included.

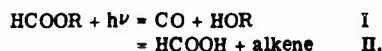
ROC.02:009

Rochester U. Dept. of Chemistry, N. Y.

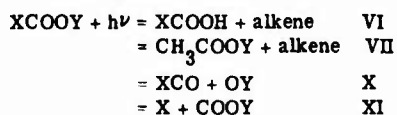
THE PHOTOLYSIS OF ALKYL ESTERS, by P. Ausloos. July 22, 1957, 26p. Incl. tables. (AFOSR-TN-57-410) (AF 18(600)1528) AD 132489
Unclassified

ROC.02:010 - ROC.02:013

An attempt has been made to determine the primary processes in the gas and liquid phase photolysis of simple alkyl esters. The liquid phase photolysis of methyl, ethyl, n-propyl and n-butyl formate has been briefly investigated. Besides the dissociation processes, two intramolecular rearrangements were found to occur:



Process I takes place with approximately the same quantum yield for all the formates studied. Process II occurs only when there is a β hydrogen in the alkyl group. An investigation of the gas and liquid phase photochemical decomposition of esters other than formates showed the existence of the following primary processes:



Processes VI and VII require β and γ hydrogens, respectively in the Y and X alkyl groups. It was found that processes I and X occur mostly at short wavelength, while the other processes take place at long wavelengths as well. (Contractor's abstract)

ROC.02:010

Rochester U. [Dept. of Chemistry] N. Y.

THE EFFECT OF SOLVENTS ON THE LIQUID PHASE PHOTOLYSIS OF ALKYL ESTERS, by P. Ausloos. Oct. 8, 1957, 17p. incl. tables. (AFOSR-TN-57-525) (AF 18(600)1528) AD 136509 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 1310-1313, Mar. 20, 1958.

The liquid phase photochemical decomposition of several alkyl esters has been studied in the presence of neopentane, n-heptane, methyl alcohol, ethyl alcohol and ethyl ether. An investigation of the effects of intensity, temperature and concentration indicated that several of the primary processes were strongly suppressed while others remained unaffected. A reaction between the electronically excited ester molecule and the solvent molecule is suggested to occur. (Contractor's abstract)

ROC.02:011

Rochester U. [Dept. of Chemistry] N. Y.

DETERMINATION OF MICROGRAM QUANTITIES OF ETHYLENE GLYCOL, by R. P. Porter. Oct. 18, 1957 [7]p. incl. diagr. table. (AFOSR-TN-57-634) (AF 18(600)1528) AD 136620 Unclassified

In a study of the vapor phase photolysis of MeOH, an analysis was made for microgram quantities of ethylene

glycol in the presence of formaldehyde. The method of analysis involves the oxidation of ethylene glycol to formaldehyde by potassium periodate, the precipitation of excess periodate by AgNO_3 , the precipitation of excess Ag^+ by NaCl , and the determination of formaldehyde by the method of Matsukawa (Jour. Biochem. (Tokyo), v. 30: 386, 1939). If larger quantities of ethylene glycol are present, the method of Hough, Powell, and Woods (Jour. Chem. Soc. (London), 4799, 1956) can be used for determining formaldehyde that is produced during the periodate oxidations of carbohydrates. (ASTIA abstract)

ROC.02:012

Rochester U. [Dept. of Chemistry] N. Y.

PHOTOCHEMICAL STUDIES. LIII. ISOPROPYL IODIDE, by G. R. McMillan and W. A. Noyes, Jr. Nov. 6, 1957, 17p. incl. diagr. tables, refs. (AFOSR-TN-57-685) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under AF 18(300)1528) AD 136681 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 2108-2111, May 5, 1958.

At 35°C, mixtures of 0.4 ml iodine with EtI, PrI, sec-BuI, and iso-PrI which were illuminated with a high-pressure mercury arc lamp produced alkenes in the ratios of 1:5:21:22; the filter was 3 mm Corning glass 3484 which absorbed wavelengths below 5070Å. MeI yielded no detectable products. Only negligible amounts of hydrocarbons were formed in thermal blanks upon irradiation of the pure alkyl iodide. Propylene was formed by the illumination of I-iso-PrI mixtures with radiation filtered for 4000 to 5510Å or for 5790Å. The ratio of butene-2 to butene-1 from sec-BuI was 3.4 and 3.7:1. The butene-2 was at least 85% the trans isomer. The rate of propylene formation was unaffected by the presence of 75 mm of dry air. The photochemical decomposition of iso-PrI was studied. H, CH_4 , and 2, 3-dimethylbutane were not products of the propylene yield in the absence of Hg at constant intensity. The rates showed a decrease only after extended photolysis. C_3H_8 was greatly decreased in the presence of added iodine, especially at the longer wavelengths, but increased after long photolysis.

ROC.02:013

Rochester U. Dept. of Chemistry, N. Y.

REACTIONS OF METHYL RADICALS WITH WATER ON QUARTZ AND PYREX SURFACES, by P. Ausloos and J. Paulson. Nov. 20, 1957, 5p. incl. table. (AFOSR-TN-57-740) (AF 18(600)1528) AD 136725; PB 135691 Unclassified

ROC.02:014 - ROC.02:017

Also published in Jour. Phys. Chem., v. 62: 501-502, Apr. 1958.

The photolysis and radiolysis of acetone- d_6 have been investigated in the presence of water. The experiments indicate that: (1) CD_3H is only formed when water is present, with as little as 0.1 mole percent of water sufficient to cause the reaction; (2) the ratio of CD_3H/CD_4 is independent of water concentration; (3) CD_3H/C_2D_6 is practically independent of the water and acetone concentrations and the ratio increases with temperature; (4) the CD_3H/CD_4 ratio falls off drastically at temperatures above 100°C in the radiolysis experiments but does not in the photolysis experiments even at temperatures up to 195°C; and (5) flaming out the pyrex and quartz cells results in a substantial decrease of the CD_3H/CD_4 ratio. These results indicate that the CD_3H is formed on the surface. Result (3) above shows that all CD_3 radicals reach the wall and that abstraction on the surface and recombination are two competing reactions.

ROC.02:014

Rochester U. [Dept. of Chemistry] N. Y.

THE PHOTOCHEMISTRY OF 2-HEXANONE VAPOR, by V. Brunet and W. A. Noyes, Jr. Oct. 30, 1957, 10p. incl. table. (AFOSR-TN-57-741) (AF 18(600)1528) AD 136727 Unclassified

Also published in Bull. Soc. Chim. (France), no. 1: 121-123, 1958.

The photochemical dissociation of 2-hexanone was studied to determine whether this reaction occurs from the upper singlet or triplet state. At room temperature and at temperatures up to 100°, propylene, and acetone quantum yields were about equal when no O was present. At temperatures above 100°, there were additional reactions to produce propylene but the acetone quantum yields remained constant up to 300°. In the presence of O, the yields of acetone and propylene were equal at all temperatures. Both yields were the same as in the absence of O up to 100°; at 150°, the acetone yield was the same in both the presence and absence of O. The fact that O did not inhibit the nonfree radical dissociation of 2-hexanone into propylene and acetone together with the independence of the quantum yields on temperature indicated that the dissociation occurs from an upper singlet state.

ROC.02:015

Rochester U. [Dept. of Chemistry] N. Y.

THE PHOTOCHEMICAL STUDY OF THE REACTION OF SIMPLE ALKYL RADICALS WITH OXYGEN, by W. A. Noyes, Jr. [1957] [8]p. incl. diag. table, refs. (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under AF 18-(600)1528) Unclassified

Published in Festschrift Arthur Stoll, Birkhäuser, Basel (Switzerland), 1957, p. 64-71.

Mechanisms of hydrocarbon oxidation reactions are complex and very difficult to elucidate. Many products are formed from even the simple hydrocarbons and usually not all products can be determined quantitatively. The absolute and even the relative rates of some of the simple steps are difficult to determine. Photochemistry offers one possible means of studying some elementary steps. The present article explores this method and attempts to state the conditions under which it can be used. (Contractor's abstract)

ROC.02:016

Rochester U. Dept. of Chemistry, N. Y.

RADIOLYSIS OF SIMPLE KETONES, by P. Ausloos and J. F. Paulson. [1958] [16]p. incl. tables, refs. (AFOSR-TN-58-253) (AF 18(600)1528) AD 154158 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 5117-5121, Oct. 5, 1958.

A brief investigation has been made of the liquid and vapor phase radiolysis of acetone, methyl ethyl ketone, and diethyl ketone. The effect of temperature and scavengers on the G-values of the volatile products has been interpreted on the basis of known radical processes. In the case of acetone it has been shown that at least 85% of the methyl radicals are thermalized before abstracting a hydrogen atom from acetone. In the liquid phase recombination products were found to be present in appreciable amounts and were not removed by iodine or DPPH at concentrations up to 2.5×10^{-2} mol/l. (Contractor's abstract)

ROC.02:017

Rochester U. [Dept. of Chemistry] N. Y.

[PHOTOISOMERIZATION PROCESSES IN CYCLIC KETONES. III. dl-CAMPHOR], by Srinivasan. May 8, 1958 [12]p. incl. table. (AFOSR-TN-58-375) (AF 18-(600)1528) AD 154282 Unclassified

ROC.02:018 - ROC.02:021

Also published in Jour. Amer. Chem. Soc., v. 81: 2604-2606, June 5, 1959.

It has been found that di-camphor, as a solution in air-free organic solvents, isomerizes under the influence of radiation of 3130A, to -campholenic aldehyde (A) and a ketone (B). B has been identified as 1,2,2-trimethylcyclopent-3-enyl methyl ketone. Quantum yields for the formation of carbon monoxide and non-volatile products have been obtained in three solvents. The ratio Φ_A/Φ_B appears to be influenced by the nature of the solvent. It is suggested that the formation of B from an excited camphor molecule proceeds in several steps involving one or more solvent molecules. (Contractor's abstract)

ROC.02:018

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOLYSES OF 2-PENTANONE AND 2-PENTANONE-1,1,1,3,3-d₅, by P. Ausloos and E. Murad. Nov. 25, 1958 [15]p. incl. tables, refs. (AFOSR-TN-58-529) (AF 18(600)1528) AD 158343 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 5929-5932, Nov. 20, 1958.

The photolyses of 2-pentanone and 2-pentanone-1,1,1,3,3-d₅ have been investigated at long wavelengths at maximum intensity of 3.7×10^{14} quanta/cc/sec and at short wavelengths. This investigation was carried out in the temperature range 25-83°C. In this study, ethylene was found to be, within experimental error, equal to the acetone yield. In the experiments with the deuterated ketone, 90% of the acetone formed was acetone-d₅.

Secondary reactions are discussed and certain ratios of rate constants are deduced. (Contractor's abstract)

ROC.02:019

Rochester U. [Dept. of Chemistry] N. Y.

THE PHOTOLYSIS OF POLYMETHYLVINYL KETONE AND POLYMETHYLISOPROPENYL KETONE, by K. F. Wissbrun. July 9, 1958 [18]p. incl. diagrs. tables, refs. (AFOSR-TN-58-588) (AF 18(600)1528) AD 162111 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 58-62, Jan. 5, 1959.

The photolysis of polymethylvinylketone (PMVK) and polymethylisopropenylketone (PMIK) was studied by using thin films of these materials. In both cases the effect of irradiation is one of depolymerization. For low dosages the effect on the mol wt of PMVK is independent of temperature, incident intensity, and film thickness. At higher dosages, however, the amount of

degradation appeared to be affected by film thickness. The results indicate formation of a double bond conjugated with the carbonyl group. The quantum yield is calculated to be 0.02. Upon photolysis at 80°C for 16 hrs, the products were determined by mass spectrometric analysis to be acetaldehyde, carbon monoxide, and methane with quantum yields of 0.06, 0.003, and 0.0006, respectively. Photolytic degradation of PMIK at 150° and 177°C yields essentially the pure monomer. A clear understanding of the mechanism of this process is complicated by dependence on temperature, mol wt, and on diffusion-controlled termination reactions.

ROC.02:020

Rochester U. Dept. of Chemistry, N. Y.

OXYGEN EFFECTS IN PHOTOCHEMICAL SYSTEMS, by W. A. Noyes, Jr. [1958] 24p. incl. tables, refs. (AFOSR-TN-58-591) (AF 18(600)1528) AD 162115

Unclassified

Presented at Internat'l. Congress of Radiation Research, Burlington, Vt., Aug. 11-15, 1958.

Also published in Radiation Research, Suppl., v. 1: 164-176, 1959.

Oxygen effects in photochemical systems have been surveyed briefly as regards the following points: (1) reactions of radicals with oxygen; (2) reactions of excited molecules with oxygen. Many radicals react rapidly with oxygen, but radicals which retain excess kinetic or vibrational energy from the primary process may undergo certain reactions which are not completely inhibited. These effects will be most easily observed with light atoms or radicals if the energy is mainly kinetic. Molecules in triplet states may react directly with oxygen without dissociating. In this case oxygen may change profoundly the nature of the primary process. (Contractor's abstract)

ROC.02:021

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOLYSIS AND FLUORESCENCE OF ACETONE AND ACETONE-BIACETYL MIXTURES, by J. Heicklen and W. A. Noyes, Jr. Sept. 12, 1958 [24]p. incl. diagrs. tables, refs. (AFOSR-TN-58-845) (AF 18(600)1528) AD 203335 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 3858-3863, Aug. 5, 1959.

The photolysis of acetone vapor has been redone at 3130A to very low conversions and the fluorescence and photolysis of acetone-biacetyl mixtures have been studied. If biacetyl is present during the photolysis of acetone at 3130A, an energy transfer occurs between

ROC.02:022 - ROC.02:025

excited acetone molecules and biacetyl, the acetone photodecomposition and phosphorescence are diminished, and biacetyl phosphorescence is observed. Since biacetyl is a reaction product of acetone photolysis, the quantum yield of acetone decomposition decreases as the time of irradiation increases. The ratios of reaction products also change with time of irradiation. A detailed mechanism is presented for the primary process in acetone and for the energy transfer between acetone and biacetyl. (Contractor's abstract)

ROC.02:022

Rochester U. Dept. of Chemistry, N. Y.

THE FLUORESCENCE OF BIACETYL VAPOR, by J. Heicklen. Sept. 12, 1958 [16]p. incl. diagrs. table. (AFOSR-TN-58-846) (AF 18(600)1528) AD 203336
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 3863-3866, Aug. 5, 1959. (Title varies)

The fluorescence and phosphorescence of biacetyl have been studied at 40° as a function of pressure and incident wavelength from 4358 Å to 3020 Å. A mechanism is proposed which explains both the light emission and the photochemistry. With incident radiation of 3020 Å or 3130 Å the absorption is into a second electronic state. This state is converted to the first singlet and triplet states, and the same fluorescence is observed as with incident radiation of longer wavelengths. This paper is combined with item no. ROC.02:023 and published as cited above. (Contractor's abstract)

ROC.02:023

Rochester U. Dept. of Chemistry, N. Y.

THE FLUORESCENCE AND PHOSPHORESCENCE OF ACETONE VAPOR, by J. Heicklen. Sept. 12, 1958 [6]p. incl. table. (AFOSR-TN-58-847) (AF 18(600)1528) AD 203337
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 3863-3866, Aug. 5, 1959.

Light emission from acetone has been studied with incident radiation from 2800 Å to 3130 Å. The fluorescence efficiency is independent of pressure and nearly independent of exciting wavelength. The phosphorescence increases markedly with wavelength and with pressure at short wavelengths. With incident radiation of 3130 Å and 40°, the phosphorescence decreases slightly as the pressure increases. At 63° the quench is more pronounced. A complete mechanism is presented. This paper is combined with item no. ROC.02:022 and published as cited above. (Contractor's abstract)

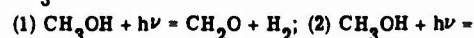
ROC.02:024

Rochester U. Dept. of Chemistry, N. Y.

PHOTOCHEMICAL STUDIES. LIV. METHANOL VAPOR, by R. P. Porter and W. A. Noyes, Jr. Sept. 12, 1958 [24]p. incl. diagrs. tables, refs. (AFOSR-TN-58-848) (AF 18(600)1528) AD 203338
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 2307-2311, May 20, 1959.

The principal products of the photochemical decomposition of methanol vapor at wave lengths below 2000 Å are hydrogen, formaldehyde, ethylene glycol together with small amounts of carbon monoxide and methane. By use of scavengers and by study of deuterated methanol, CD₃OH, at least two primary processes must occur:



CH₃O + H. Other primary processes, including the formation of hot methoxy radicals and hot hydrogen atoms, may occur but conclusive evidence for or against them could not be obtained. Secondary reactions are discussed. Methoxy radicals must, by abstraction, form CH₂OH radicals, and CH₂OH radicals must also be formed by the reaction $\text{H} + \text{CH}_3\text{OH} = \text{CH}_2\text{OH} + \text{H}_2$. (Contractor's abstract)

ROC.02:025

Rochester U. Dept. of Chemistry, N. Y.

PHOTOISOMERIZATION PROCESSES IN CYCLIC KETONES. I. CYCLOPENTANONE AND CYCLOPENTANONE-2,2,5,5-d₄, by R. Srinivasan. Nov. 12, 1958 [13]p. incl. tables, refs. (AFOSR-TN-58-998) (AF 18(600)1528) AD 206141
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 1546-1549, Apr. 5, 1959.

4-Pentenal has been identified as one of the products of the vapor phase photolysis of cyclopentanone at 3130 Å. Quantum yields for the formation of 4-pentenal have been obtained at various temperatures and in the presence of added oxygen and carbon dioxide. The photolysis of cyclopentanone-2,2,5,5-d₄ has been found to give

tetradutero 4-pentenal, the structure of which is most probably CD₂ = CHCH₂CD₂CHO. On the basis of these results, it is deduced that the photoisomerization of cyclopentanone to 4-pentenal involves a direct transfer of a hydrogen atom from a β-carbon to the carbonyl group in an excited state of the ketone molecule. (Contractor's abstract)

ROC.02:026, 027; ROC.03:031-033

ROC.02:026

Rochester U. Dept. of Chemistry, N. Y.

RADIOLYSIS OF $\text{CH}_3\text{COOCH}_3$ AND $\text{CH}_3\text{COOCD}_3$ BY COBALT-60 GAMMA-RAYS, by P. Ausloos and C. N. Trumbore. Dec. 2, 1958, 22p. incl. tables, refs. (AFOSR-TN-58-1067) (AF 18(600)1528) AD 207227
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 3866-3871, Aug. 5, 1959.

Results of studies on the radiolysis of liquid and gaseous $\text{CH}_3\text{COOCH}_3$ and $\text{CH}_3\text{COOCD}_3$ by cobalt 60 gamma radiation are reported. Yields of the volatile radiation decomposition products have been studied as a function of temperature, dose and the presence of added radical scavengers. A comparison of the isotopic hydrogen, methane, ethane and dimethyl ether species present in these products provides information about possible primary processes, hot radical effects and radical disproportionation and recombination reactions within the liquid "cage." Recombination of methyl radicals originating from the same parent molecule as well as abstraction reactions between radicals in the same cage are postulated to explain the non-statistical yields of CH_3CD_3 and the high yields of CH_3D and CH_3OCD_3 in the liquid phase. (Contractor's abstract)

ROC.02:027

Rochester U. Dept. of Chemistry, N. Y.

PHOTOISOMERIZATION PROCESSES IN CYCLIC KETONES. II. CYCLOHEXANONE AND 2-METHYLCYCLOHEXANONE, by R. Srinivasan. Dec. 20, 1958 [13]p. incl. table, refs. (AFOSR-TN-58-1128) (AF 18(600)1528) AD 207973; PB 139862
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 2601-2604, June 5, 1959.

5-Hexenal has been identified as one of the products of the vapor phase photolysis of cyclohexanone at 3130 Å. Quantum yields for the formation of 5-hexenal have been obtained as a function of temperature and pressure and in the presence of oxygen or carbon dioxide. The photoisomerization also occurs in the pure liquid phase and in methylpentane solution. The photolysis of 2-methylcyclohexanone as a pure liquid apparently gives rise to only one isomeric product, which is most probably trans-5-heptenal. The photoisomerization of these two ketones closely resembles the corresponding process in cyclopentanone and probably proceeds by the same mechanism. (Contractor's abstract)

ROC.03:031

Rochester U. Dept. of Physics, N. Y.

THE CLOSE-PAIR EFFECT IN COSMIC RAY STARS AT 92,000 FEET, by M. E. Matsis and M. F. Kaplon. n.d. 3p. incl. diagrs. [AF 18(600)380] Unclassified

A study of the close-pair correlation of cosmic ray induced stars in a nuclear emulsion has been carried out with inconclusive results. The stars produced by the decay of thorium which is present in the emulsion has been used as a comparison. A plot of the difference of close-pair expected values and observed values shows a larger than expected occurrence for the star center separation of less than 600μ . If the thorium graph can be accepted as a criterion for randomness, then no close-pair effect is observed in the cosmic ray stars.

ROC.03:032

Rochester U. Dept. of Physics, N. Y.

LIFETIMES OF τ , $K_{\mu 3}$ AND K_e DECAY MODES, by T. F. Hoang, M. F. Kaplon, and G. Yekutieli. Sept. 5, 1956 [25]p. incl. diagrs. tables, refs. (Rept. no. NYO 7677) (AFOSR-TN-57-441) (Sponsored jointly by Atomic Energy Commission under AT(30-1)875 and Air Force Office of Scientific Research under AF 18(600)380) AD 114573
Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Nov. 23-24, 1956.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 1: 320, Nov. 23, 1956.

Also published in Phys. Rev., v. 105: 278-284, Jan. 1, 1957.

The proportions of the various decay modes of K^+ -mesons produced by the 2.9 bev proton beam of the Brookhaven Cosmotron have been investigated in two emulsion stacks separately exposed at different distances from the target. An analysis of the observed ratios of different decay modes has been made in order to determine the various partial lifetimes using the $K_{\mu 2}$ and $K_{\pi 2}$ lifetimes as a secondary standard. The results indicate that within experimental error all the partial lifetimes are consistent with a unique value.

ROC.03:033

Rochester U. [Dept. of Physics] N. Y.

MAXIMUM LIKELIHOOD ESTIMATION OF K^+ -MESON LIFETIME, by D. F. Davis, T. F. Hoang, and M. F. Kaplon. Feb. 25, 1957 [6]p. incl. tables. (Rept. no. NYO 7819) (AFOSR-TN-57-442) (Sponsored jointly by

ROC.03:034 - ROC.03:037

Atomic Energy Commission under AT(30-1)875 and Air Force Office of Scientific Research under AF 18-(600)380 AD 134726
Unclassified

Also published in Phys. Rev., v. 106: 1049-1050, June 1, 1957.

The method of maximum likelihood is applied to the observations of the decay in flight of K_L^+ and τ^+ mesons in emulsion. The values obtained are $(1.19 \pm 0.17) \times 10^{-8}$ sec and $(1.06 \pm 0.53) \times 10^{-8}$ sec, respectively. Possible sources of error in the application of this method to K^+ beams in emulsion are discussed.

ROC.03:034

Rochester U. Dept. of Physics, N. Y.

OBSERVATIONS ON THE $\pi^+ - \mu^+ - e^+$ ANGULAR CORRELATION IN NUCLEAR EMULSION, by D. F. Davis, A. Engler and others. May 1, 1957 [18]p. incl. diagrs. (Rept. no. NYO 4842) (AFOSR-TN-57-443) (Sponsored jointly by Atomic Energy Commission under AT(30-1)875 and Air Force Office of Scientific Research under AF 18(600)380) AD 134724
Unclassified

Also published in Nuovo Cimento, Series X, v. 6: 311-318, Aug. 1, 1957.

The asymmetry coefficient characterizing the angular correlation in the $\pi - \mu - 3$ decay has been measured in emulsion as -0.19 ± 0.06 for a sample of π^+ -mesons produced at the Brookhaven Cosmotron. A discussion is given concerning depolarization effects in nuclear emulsion.

ROC.03:035

Rochester U. Dept. of Physics, N. Y.

INTERACTION OF K^+ -MESONS IN THE INTERVAL 30-65 MEV, by T. F. Hoang, M. F. Kaplon, and R. Cester. June 3, 1957 [39]p. incl. diagrs. tables, refs. (Rept. no. NYO 4844) (AFOSR-TN-57-444) (Sponsored jointly by Atomic Energy Commission under AT(30-1)-875 and Air Force Office of Scientific Research under AF 18(600)380) AD 134725
Unclassified

Also published in Phys. Rev., v. 107: 1698-1708, Sept. 15, 1957.

A systematic study of the scattering of 1173 definitely identified K_L^+ -mesons and 279 τ (including τ') mesons has been made in the energy interval 30-65 mev using photoemulsion exposed to the Berkeley K^+ -meson beam. All scatters of K^+ -mesons having a projected angle greater than 2° on the emulsion plane were recorded and

analyzed. The results of analysis are the following: (1) the interaction properties of the K_L^+ and τ -mesons are essentially indistinguishable; (2) the coherent nuclear scattering of K^+ -mesons interferes constructively with the Coulomb scattering; (3) in terms of the optical model, the best fit for coherent scattering corresponds to a real potential of $\sim +15$ mev, and the inelastic scattering gives an imaginary potential of ~ 3.6 mev; and (4) charge exchange is rare in this energy region: $\sigma(\text{charge exchange})/\sigma(\text{incoherent}) < 1/10$. A tentative interpretation of the results in terms of isospin $T = 0$ and $T = 1$ states is presented. A discussion is also given on the characteristic features of K^+ -stars. (Contractor's abstract)

ROC.03:036

Rochester U. [Dept. of Physics] N. Y.

SCATTERING OF K_L^+ AND τ MESONS (Abstract), by T. F. Hoang, M. F. Kaplon, and R. Cester. [1957] [1]p. (Sponsored jointly by Atomic Energy Commission and Air Force Office of Scientific Research under [AF 18(600)-380])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 20, Jan. 30, 1957.

A systematic study of the scattering of 1175 K_L^+ mesons and 242 τ and τ' mesons has been made in the energy region of 20 to 80 mev using Bevatron K^+ mesons recorded in Ilford G5 emulsions. All scatters of K meson having a projected angle greater than 2° in the emulsion plane were analyzed. A scattering is accepted as elastic if no energy loss can be detected on the basis of ionization and range. The same differential cross section of elastic scattering was observed for K_L^+ and τ mesons.

An attempt was made to separate nuclear scattering from coulomb scattering by means of an energy-dependent cutoff. The elastic nuclear scatterings thus found gave a mean free path of $44(+6, -4)$ cm for the K_L^+ meson and $43(+12, -8)$ cm for the τ meson; their angular distribution shows the characteristic features of a diffraction scattering. The ratio of inelastic to elastic ($\Delta E/E < 10\%$) scatterings of K_L^+ and τ mesons was found to be $\sim 1/11$.

ROC.03:037

Rochester U. [Dept. of Physics] N. Y.

ON THE FLUX OF COSMIC-RAY PARTICLES WITH $Z \geq 2$ AT $\lambda = 41^\circ N$ (Abstract), by A. Engler, M. F. Kaplon, and J. Klarmann. [1957] [1]p. [AF 18(600)380]
Unclassified

ROC.03:038 - ROC.03:041

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2:
192, Apr. 25, 1957.

A stack of nuclear emulsions has been exposed to the cosmic radiation under $\sim 8 \text{ g/cm}^2$ of matter at $\lambda = 41^\circ \text{N}$. Since at this latitude all incoming particles are nearly relativistic, ionization measurements are sufficient to determine their charge. Blob-and-gap measurements were made on the tracks of α particles, and δ -ray counts on those of particles with $Z \geq 3$. The obtained fluxes were presented and compared with those of other authors.

balloon flight. The identification of α -particles was based on "blob-gap" measurements while those of elements with $Z \geq 3$ were based on δ -ray densities. The charge resolution obtained was satisfactory. To calculate the fluxes at the top of the atmosphere an extrapolation procedure was used. Two sets of parameters which account for the interactions in the residual atmosphere, differing considerably as far as their influence on the fluxes of light elements is concerned, were used. The results (in particles/ $\text{m}^2 \text{ sec sterad}$) are:

	Set I	Set II
$Z = 2$	90.9 ± 8.0	89.2 ± 8.0
$3 \leq Z \leq 5$	1.68 ± 0.32	0.45 ± 0.36
$6 \leq Z \leq 9$	5.60 ± 0.58	6.05 ± 0.56
$Z \geq 10$	2.19 ± 0.38	2.19 ± 0.38

(Contractor's abstract)

ROC.03:038

[Rochester U. Dept. of Physics, N. Y.]

PROCEEDINGS OF THE SEVENTH ANNUAL ROCHESTER CONFERENCE ON HIGH ENERGY NUCLEAR PHYSICS, N. Y., Apr. 15-19, 1957, ed. by G. Ascoli, G. Feldman, and others. N. Y., Interscience Publishers Inc., 1957, 1v. incl. illus. diagrs. tables, refs. (In cooperation with Midwestern Universities Research Association, Wisconsin U., Madison) [AFOSR-TN-58-54] (Sponsored jointly by National Science Foundation, International Union of Pure and Applied Physics, Atomic Energy Commission, and Air Force Office of Scientific Research under [AF 18(600)380])

Unclassified

The purpose of this conference was to bring together a representative group of active workers from high energy physics labs. throughout the world for an informal and complete discussion of the experimental and theoretical developments during the previous year. The topics presented are: (1) Structure of the Nucleon; (2) Pion Reactions; (3) Nucleon-Nucleon Interaction; (4) Theoretical Physics; (5) High-Energy Collision Phenomena; (6) Strange Particle Interactions; (7) Weak Interactions; (8) Miscellaneous Topics (Strange Particles); (9) Strange Particles and Weak Interactions; (10) Antibaryon Phenomenon; and (11) Multiple Meson Production.

ROC.03:040

Rochester U. [Dept. of Physics] N. Y.

K^+ -MESON INTERACTIONS IN NUCLEAR EMULSIONS (Abstract), by D. F. Davis and M. F. Kaplon. [1958] [1]p. [AF 18(600)380] Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 270, June 19, 1958.

The interactions of K^+ -mesons of energies up to 250 mev are being studied. A stack of emulsion consisting of 80 pellicles, each 400 μ thick and 25 cm x 9.3 cm in area, was exposed to the "separated" K^+ -meson beam at the Berkeley Bevatron. The stack has the advantage that it is large enough to stop K^+ mesons of 250 mev. This allows the stopping particles to be identified by their characteristic decay modes. The energy dependence of the cross section and of the ratio, charge exchange/inelastic scatter, are presented. These results are based on the data from about 30 meters of track.

ROC.03:039

Rochester U. Dept. of Physics, N. Y.

FLUX OF COSMIC-RAY PARTICLES WITH $Z \geq 2$ OVER TEXAS, by A. Engler, M. F. Kaplon, and J. Kiarman. [1958] [33]p. incl. diagrs. tables, refs. (AFOSR-TN-58-670) [AF 18(600)380] AD 162202 Unclassified

Also published in Phys. Rev., v. 112: 597-605, Oct. 15, 1958.

The fluxes of multiply charged cosmic ray particles were measured with nuclear emulsions in a high altitude

ROC.03:041

[Rochester U. Dept. of Physics, N. Y.]

DETERMINATION OF Λ^+ - Q VALUE IN NUCLEAR EMULSIONS, by J. Crussard, M. Kaplon and others. n.d. [18]p. incl. diagrs. tables. [AF 18(600)380; continued by AF 49(638)303] Unclassified

A systematic search for Λ^+ decays was carried out in emulsions exposed to the cosmic radiation. Careful attention was paid to the problem of background events appearing qualitatively as Λ^+ decays as well as to biases introduced by experimental procedure. The Q-value for

ROC.07:001, 002; ROC.08:001;
ROC.09:001

the Λ^0 decay was measured to be 36.6 ± 0.4 mev and the Λ^0 mass 2181.1 ± 1 m_e. No evidence was found for the existence of other neutral particles decaying into $\pi^- + P + Q$, for $Q < 35$ mev, if their abundance is comparable to that of the Λ^0 . (Contractor's abstract)

ROC.07:001

Rochester U. Dept. of Physics, N. Y.

THE STRUCTURE OF THE M DWARF STARS. I, by D. N. Limber. [1958] [24]p. incl. diagrs. tables, refs. [AF 49(638)52] Unclassified

Published in *Astrophys. Jour.*, v. 127: 363-386, Mar. 1958.

The problem of the internal structure of the middle and late M dwarf stars is considered, and the discrepancy between theory and observation that had been found by Osterbrock for these stars is reexamined. A rediscussion of the observations that relate to the masses, luminosities, and radii for the stars whose spectral types range from M4 V to M8 V is carried out on the basis of what are believed to be the best and most recent data; and revised values and probable errors for these observational quantities are determined. The evidence is found to indicate rather strongly that the bolometric corrections that are usually quoted in the literature should be reduced by at least 0.3 or 0.4 mag. for the stars of spectral type M4 V and by correspondingly larger values for the still later spectral types. Some indication is also found that the effective temperatures of the middle and late M dwarfs are actually higher than the values usually quoted. These suggested corrections act to reduce significantly the discrepancy between Osterbrock's theory and the observations and lend support to the view that the middle and late M dwarfs are completely convective insofar as their interiors are concerned. (Contractor's abstract)

ROC.07:002

Rochester U. Dept. of Physics, N. Y.

THE STRUCTURE OF THE M DWARF STARS. II, by D. N. Limber. [1958] [41]p. incl. diagrs. tables, refs. [AF 49(638)52] Unclassified

Published in *Astrophys. Jour.*, v. 127: 387-427, Mar. 1958.

The theory of completely convective models is developed specifically for application to the middle and late M dwarfs in such a way that the effects of electron degeneracy are taken into account, and the restrictions that are set upon the realm of applicability of these models by the effects of radiative transport and of electron conduction are determined. Under rather general

assumptions, the results of the theory can be expressed in analytical form. The required formulae and equations that describe these models and that give the criteria for their applicability are derived for an arbitrary chemical composition in terms of rather general expressions for the rate of energy production and for the radiative opacity. The corresponding convective models have been constructed for the relevant range of values for the masses and radii and for what appear to be the best present estimates for the chemical composition, rate of energy generation, and radiative opacity. The effects of the atmospheres for these models are examined insofar as they determine the mass-luminosity relation and enter into the comparison of the theory of the interiors with the observations. The models that have been constructed have been compared with the observational values for the masses, luminosities, and radii for Krüger 60 A (M4 V) and Krüger 60 B (M6 V) that were obtained from the rediscussion of the observations in Paper I, and theory and observation have been found to be consistent. (Contractor's abstract)

ROC.08:001

Rochester U. Dept. of Physics, N. Y.

SOME CONSIDERATIONS ON THE ANALYSIS OF PRIMARY COSMIC RAY INTENSITY EXPERIMENTS, by A. Engler, M. F. Kaplon, and J. Klarmann. [1958] [34]p. incl. diagr. refs. (AFOSR-TN-58-970) [AF 49(638)303; continuation of AF 18(600)380] AD 205597; PB 144001 Unclassified

Also published in *Nuovo Cimento, Series X*, v. 12: 310-326, May 16, 1959.

A discussion is given of the procedures employed in the analysis of primary cosmic ray intensity experiments and the assumptions inherent in their use, with particular emphasis on nuclear emulsion as a detector. Explicit formulae for extrapolation of particle intensities for various geometries employed in emulsion work are given. Some discussion of geomagnetic effects is given and data are presented showing that the earth's shadow cone is not appreciably present at a geomagnetic latitude of 40°. (Contractor's abstract)

ROC.09:001

Rochester U. [Dept. of Physics] N. Y.

PROCEEDINGS OF THE 1959 INTERNATIONAL CONFERENCE ON SEMICONDUCTORS, ROCHESTER, AUGUST 18-22, ed. by H. Brooks, H. B. G. Casimir and others. N. Y., Pergamon Press, Inc., 1959, 552p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)-688, Task 2 and AF 49(638)396], Atomic Energy Commission, National Science Foundation, and Office of Naval Research) Unclassified

ROC.04:007 - ROC.04:011

Published in Jour. Phys. Chem. Solids, v. 8: 1-552, Jan. 1959.

The following topics were included in the conference sessions: Band Structure, Lattice Vibrational Spectrum, Recombination and Trapping, Magnetic Resonance, Optical and Magneto-optical Effects, Galvanomagnetic Effect, Surface States, Impurity Levels, Transport Properties, Structural Defects, Excitons, and Thermoelectric Effects.

ROC.04:007

Rochester U. Inst. of Optics, N. Y.

FINE STRUCTURE IN THE EXCITON BANDS OF THE ALKALI HALIDES, by K. Neegarden. June 1957 [15]p. incl. diagrs. table. (AFOSR-TN-57-370) (AF 18(600)-193) AD 132442
Unclassified

Also published in Phys. Rev., v. 108: 660-662, Nov. 1, 1957.

New data is presented on the optical absorption spectra of evaporated films of KI, NaI, RbI, NaBr, and KBr in the region between 1700Å and 2500Å. The measurements were made at room temperature and -180°C. The absorption spectra of the iodides reveal hitherto unreported structure in the fundamental band region of the salts.

ROC.04:008

Rochester U. Inst. of Optics, N. Y.

PHOTOLYTIC ACTION OF X-RAYS ON AgCl and AgBr CRYSTALS, by S. Tutihasi. Oct. 1957 [6]p. incl. diagrs. (Technical note no. 20 under AF 18(600)688 and technical note no. 10 under AF 18(600)193) AD 136646
Unclassified

Attempts were made to produce optical absorption bands in the spectral region between 400 mμ and 2 mμ in AgCl and AgBr crystals by x-raying the crystals at liquid nitrogen temperature. The results were negative. After 7 hr exposure the optical absorption was found to be 70 times smaller than that of KCl. Intermittent x-rays at low temperatures were used with no appreciable change in the absorption spectra. Room temperature x-ray exposure produced a colloid band at 600 mμ. When a 5 min pre-exposure at room temperature was performed prior to a 4 hr low temperature irradiation, the colloid band was again observed but only after the 4 hr exposure.

ROC.04:009

Rochester U. Inst. of Optics, N. Y.

ULTRAVIOLET SENSITIVITY OF LEAD SULFIDE

PHOTOCELLS, by A. Smith and D. Dutton. Dec. 1957 [10]p. incl. diagrs. refs. (Technical note no. 11) (AFOSR-TN-58-35) (AF 18(600)193) AD 148074
Unclassified

Also published in Jour. Opt. Soc. Amer., v. 48: 1007-1009, Dec. 1958. (Title varies)

Spectral response measurements have been made on Eastman Kodak lead sulfide photocells in the wavelength range 0.2 - 2.0μ. The quantum sensitivity is roughly constant for wavelengths greater than 0.6μ, and rises linearly with photon energy at shorter wavelengths. The increase in quantum yield is attributed to secondary internal photoemission. (Contractor's abstract)

ROC.04:010

Rochester U. Inst. of Optics, N. Y.

ANISOTROPY OF EDGE LUMINESCENCE IN CADMIUM SULFIDE, by D. Dutton. Jan. 1958 [6]p. incl. diagr. (Technical note no. 12) (AFOSR-TN-58-56) (AF 18(600)193) AD 148097
Unclassified

Also published in Jour. Phys. Chem. Solids, v. 6: 101-102, July 1958.

Observations were made on the luminescence produced with polarized light to obtain additional evidence for an indirect excitation mechanism and to provide some information on the anisotropy of the luminescence centers and their distribution within the crystal. The observations were made in connection with an investigation of the optical absorption spectrum of CdS. The specimen which was a single crystal in the form of a thin platelet was maintained at 90°K and illuminated by monochromatic polarized light. The intensity and polarization of the luminescence were measured as functions of wavelength and polarization of the exciting radiation. The results showed that the emission at 5205Å was strongly polarized, and the component with E vector perpendicular to the c-axis was 6.3 ± 0.2 times as intense as the parallel component. This ratio was independent of the polarization of the exciting radiation, implying that the excitation and emission processes are only directly related and may occur in different states or in different parts of the crystal. The excitation spectrum showed pronounced peaks coincident with absorption maxima, indicating that the luminescence efficiency was appreciably higher near the surface.

ROC.04:011

Rochester U. Inst. of Optics, N. Y.

A SIMPLE WIDE RANGE SPECULAR REFLECTOMETER, by R. F. Weeks. May 1958 [11]p. incl. illus. diagrs. (Technical note no. 13) (AFOSR-TN-58-513) (AF 18(600)193) AD 158324
Unclassified

ROC.04:012 - ROC.04:015

Also published in Jour. Opt. Soc. Amer., v. 48: 775-777, Nov. 1958.

A wide range absolute specular reflectometer of simple design has been built to measure the absolute reflectivity of single crystals at liquid nitrogen temperature. The basic design, theory of operation, and inherent limitations of the design are discussed in terms of the spectra and temperature regions attainable. The instrument, built at the Institute of Optics is shown as well as samples of measured reflectivities. (Contractor's abstract)

ROC.04:012

Rochester U. Inst. of Optics, N. Y.

THE FUNDAMENTAL ABSORPTION EDGE IN CADMIUM SULFIDE, by D. Dutton. June 1958, 20p. diags. refs. (Technical note no. 14) (AFOSR-TN-58-545) (AF 18(600)193) AD 158362 Unclassified

Also published in Phys. Rev., v. 112: 785-792, Nov. 1, 1958.

The absorption and reflection spectra of CdS have been determined in the temperature range 90°-340°K by photoelectric measurements on single crystals, using polarized light. The temperature and frequency dependence of the absorption coefficient in the edge, over a substantial range of absorption magnitudes, are well described by expressions of the form $\alpha(\nu) = \alpha_0 \exp \left\{ -\frac{\beta(E_{00} - CT - h\nu)/kT \right\}$, where the energy $(E_{00} - CT)$ is closely associated with the position of an absorption peak. For light polarized with E vector parallel to the crystalline c-axis, there is one such peak, at $\lambda 4844\text{Å}$ at 90°K; for light polarized with E vector perpendicular to the c-axis, the 4844Å absorption is again present in about equal strength and a stronger line appears at $\lambda 4874\text{Å}$, shifting the absorption edge toward longer wavelengths by a corresponding amount. These absorption lines, or sharp bands, are observed in the reflectance spectrum, and correspond to absorption lines observed photographically by Gross and others. These results are discussed in the light of the present theoretical picture of absorption in insulating crystals, and it is noted that an exponential absorption edge of this kind, characteristic also of other ionic crystals, cannot be adequately explained in terms of existing models. (Contractor's abstract)

ROC.04:013

Rochester U. Inst. of Optics, N. Y.

A SIMPLE PULSED ULTRAVIOLET LIGHT SOURCE, by R. F. Weeks. Sept. 1958 [18]p. incl. illus. diags. (Technical note no. 15) (AFOSR-TN-58-615) (AF 18(600)193) AD 162143 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 49: 429-433, May 1959.

A pulsing circuit to permit the use of a conventional low pressure "Nester" hydrogen arc as an ultraviolet stimulating source for luminescence studies is described. The pulse duration may be varied from 4 msec to 30 μsec with a repetition rate of 60 per sec. There is no perceptible variation of the light form from pulse to pulse. The rise time of the pulses is 20 μsec and the fall time, 0.3 μsec . The pulsing circuit is assembled from conventional electronic components and contains no critical high frequency circuits. The inherent spectral range and reliability of operation of the Nester lamp are maintained and the unit may be easily switched to dc operation. The use of this source in kinetics measurements is discussed briefly. (Contractor's abstract)

ROC.04:014

Rochester U. Inst. of Optics, N. Y.

RESEARCH ON OPTICAL AND ELECTRICAL PROPERTIES OF SOLIDS, by D. Dutton. Final rept. Sept. 1958, 8p. (Technical note no. 16) (AFOSR-TN-58-100) (AF 18(600)193) AD 162214 Unclassified

The research carried out during this contract is summarized and abstracts of the reports and publications issued under the contract are presented. The work was initially directed toward investigation of intergrain potential barriers in polycrystalline lead sulfide photo-cells, using a microbeam scanning technique, with a view to establishing the properties of such barriers. The scope of the project was later broadened to include experimental studies of photoconductivity, luminescence, and optical absorption in various materials including the alkali and silver halides, the thallous halides, cadmium sulfide, lead sulfide, and lead selenide. (See item nos. ROC.04:001-ROC.04:013, ROC.04:015, and ROC.05:012-013 in Vols. I and II of this bibliography.)

ROC.04:015

Rochester U. [Inst. of Optics] N. Y.

LUMINESCENCE OF "PURE" ALKALI IODIDES (Abstract), by R. F. Weeks and K. Teegarden. [1958] [1]p. [AF 18(600)193; continued by AF 49(638)433] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 127, Mar. 27, 1958.

Further measurements on the low temperature luminescence of "pure" alkali iodides excited by light in the region of the fundamental band have been made. Previously

ROC.05:020 - ROC.05:023

reported work on the luminescence of KI (item no. ROC.04:004) has been extended to include measurements of the lifetime of the luminescence and the temperature dependence of the quantum yield. A study has also been made of the luminescence of "pure" RbI. The results of this work are discussed in terms of possible models for the electronic processes involved in the luminescence.

ROC.05:022

Rochester U. Inst. of Optics, N. Y.

RESISTIVITY OF INTERSTITIALS IN COPPER, by R. J. Potter and D. L. Dexter. June 1957 [23]p. incl. diagrs. tables, refs. (Rept. no. 18) (AFOSR-TN-57-327) (AF 18(600)688) AD 132399 Unclassified

Also published in Phys. Rev., v. 108: 677-682, Nov. 1, 1957.

The residual resistivity of copper per atomic percent of interstitial atoms is computed in several different models. It is found that the contributions from the defect itself and from the associated lattice strain are of comparable magnitude and that the interference between them tends to reduce the resistivity. A shielded Coulomb potential, Blatt's computed phase shifts, and an electron-lattice interaction constant are variously used to calculate the scattering amplitudes. The necessary parameters are determined from high-temperature resistivity data. Values of about $2 \mu\text{ohm cm}$ per atomic percent are obtained. (Contractor's abstract)

ROC.05:020

Rochester U. Inst. of Optics, N. Y.

ON THE POSSIBILITY OF LUMINESCENT QUANTUM YIELDS GREATER THAN UNITY IN INORGANIC CRYSTALS, by D. L. Dexter. Apr. 1957, 12p. (Rept. no. 16) (AFOSR-TN-57-172) (AF 18(600)688) AD 126466 Unclassified

Also published in Phys. Rev., v. 108: 630-633, Nov. 1, 1957.

It is shown that an excited sensitizer can transfer its energy simultaneously to two activators, under suitable conditions, leading to two emitted photons per incident higher energy photon. The probability of this transfer process is computed, and the process is shown to be experimentally feasible. (Contractor's abstract)

ROC.05:023

Rochester U. Inst. of Optics, N. Y.

ANISOTROPIC EFFECTS IN OPTICAL EXCITATION OF EXCITONS IN MOLECULAR CRYSTALS, by D. Fox and S. Yatsiv. Sept. 1957, 41p. incl. refs. (Rept. no. 19) (AFOSR-TN-57-597) (AF 18(600)688) AD 136583 Unclassified

Also published in Phys. Rev., v. 108: 938-945, Nov. 15, 1957.

The expression for the energy of an exciton state contains certain dipole lattice sums. These sums are strongly dependent on the direction of the propagation vector of the exciton, even when the magnitude of this vector is very small. As a result, the energy of an optically-excited exciton may depend strongly on the direction of propagation of the absorbed radiation, if the excitation takes place coherently over a region whose linear dimensions are comparable with or much larger than a wavelength. The behavior of the lattice sums may also introduce a dependence of the exciton polarization and of the absorption coefficient on the direction of propagation. The magnitudes of these effects were calculated for the cases of the first and second transitions of naphthalene and of anthracene. Experimental observations of the extent to which these effects occur could provide information on the dimensions of excitation of the exciton.

ROC.05:021

Rochester U. Inst. of Optics, N. Y.

ON EXCITON MODELS IN THE ALKALI HALIDES, by D. L. Dexter. Apr. 1957 [23]p. incl. diagrs. refs. (Rept. no. 17) (AFOSR-TN-57-198) (AF 18(600)688) AD 126493 Unclassified

Also published in Phys. Rev., v. 108: 707-712, Nov. 1, 1957.

The common models for excitons in the alkali halides are criticized as to their goodness as zero-order models. Some new calculations on energies, oscillator strengths, and charge distributions are made with the models as they are commonly used. It is shown that the customary use of an LCAO (linear combination of atomic orbitals) method with the electron transfer model gives qualitatively incorrect results, particularly for the wave functions and charge distributions, results which are not even internally consistent with the model. It is argued that the other model, an excitation model, gives at least semiquantitatively correct results, and is a satisfactory zero-order approximation. Finally, it is shown that in the alkali halides the LCAO method must inevitably be an inconvenient one for finding accurate charge distributions and wave functions for localized centers. (Contractor's abstract)

ROC.05:024 - ROC.05:028

ROC.05:024

Rochester U. Inst. of Optics, N. Y.

EXCITED STATE WAVE FUNCTIONS, EXCITATION ENERGIES AND OSCILLATOR STRENGTHS FOR

ARGON ($3p^5 4s$), by R. S. Knox. Dec. 1957 [24]p. incl. tables, refs. (Technical note no. 21) (AFOSR-TN-57-791) (AF 18(600)688) AD 148023 Unclassified

Also published in Phys. Rev., v. 110: 375-381, Apr. 15, 1958.

Solutions of the Hartree-Fock equations for the $3P$ and $1P$ terms of argon ($3p^5 4s$) have been obtained. Wave functions are tabulated and results of computations of excitation energies and oscillator strength are presented. The computed values for the excitation energies are found to agree with experimental values to within 4%. Predicted oscillator strengths for absorption at 1049A and 1067A are 0.66 and 0.16, respectively, with an estimated error of 10 to 20%. (Contractor's abstract)

ROC.05:025

Rochester U. Inst. of Optics, N. Y.

THE REFRACTIVE INDEX AND FARADAY EFFECT IN SOLID SOLUTIONS, by D. L. Dexter. Feb. 1958 [18]p. incl. diagrs. refs. (Technical note no. 22) (AFOSR-TN-58-286) (AF 18(600)688) AD 154190

Unclassified

Also published in Phys. Rev., v. 111: 119-124, July 1, 1958.

The change in the index of refraction and the magnitude of the Faraday effect are computed for nonmetallic crystals (or solutions) containing impurities or color centers. Both effects are found to be easily measurable. Previous experimental and theoretical studies are compared. (Contractor's abstract)

ROC.05:026

Rochester U. Inst. of Optics, N. Y.

EXCITON STATES IN SOLID ARGON, by R. S. Knox. Apr. 1958, 292p. incl. diagrs. tables, refs. (Technical note no. 23) (AFOSR-TN-58-370) (AF 18(600)688) AD 154276

Unclassified

The ground and lowest excited states of a rare gas crystal are treated in the tight-binding approximation. Frenkel exciton states constructed from symmetrically-orthogonalized states of localized excitation are used and intermediate coupling of singlet and triplet states is carried out in order to include atomic spin-orbit

interaction. Expressions for energies, effective masses, and integrated absorption cross sections associated with the lowest optically interesting states are obtained in an approximation which considers overlapping of atomic wave functions through terms of order equal to the square of the overlap in the integration and which neglects perturbations by single exciton states other than the 12 belonging to the lowest configuration. Lattice vibrations are not explicitly taken into account. The formalism is applied to solid argon using atomic Hartree-Fock wave functions. Exciton bands built from certain atomic $J = 2$ states have appreciable perturbing effects on the optically interesting bands, and certain interaction terms which depend explicitly on overlap integrals are decisive in determining the sign of the exciton effective masses. The model predicts two absorption lines in the vicinity of 9 ev (± 1 ev) with a separation of 0.2 ev and a combined integrated absorption cross section of the order of 10^6 ev cm^{-1} . The estimated computational error in excitation energy arises in part from difficulties in evaluating 2- and 3-center integrals in the presence of large overlap and in part from the natural inaccuracy of the atomic Hartree-Fock functions. Exciton effective masses are relatively insensitive to the direction of the momentum vector k and are of the order of 5 electron masses.

ROC.05:027

Rochester U. Inst. of Optics, N. Y.

THEORETICAL INVESTIGATIONS OF THE EFFECTS OF IMPERFECTIONS ON THE OPTICAL PROPERTIES OF SOLIDS, by D. L. Dexter. Final rept. Aug. 1958, 9p. (Technical note no. 24) (AFOSR-TR-58-105) (AF 18(600)688) AD 201513

Unclassified

This report summarizes the work performed on the above contract over a five-year period, on the subject of optical and electrical properties of solids. Abstracts and literature references are presented for the reports and publications originating from the contract. (See item nos. ROC.04:006 and 008 and ROC.05:001-007, 009-013, 015-017, and 020-026 in vols. I and II of this bibliography.)

ROC.05:028

Rochester U. [Inst. of Optics] N. Y.

OPTICAL PROPERTIES OF SOLIDS, by D. L. Dexter. [1958] [42]p. incl. diagrs. refs. [AF 18(600)688; continued by AF 49(638)432]

Unclassified

Presented at Internat'l. School of Physics, Varenna (Italy), July 14-Aug. 3, 1957.

Published in Nuovo Cimento, Series X, Suppl., v. 7: 245-286, 1958.

ROC.10:001; ROC.11:001, 002;
ROM.04:001; ROM.02:002

This paper contains a series of 3 lectures on the subject of the theory of optical properties of non-metallic solids. The topics discussed are: optical band-to-band transitions, properties of excitons, and the interpretation of optical properties of isolated imperfections on the basis of the "configuration co-ordinate" model.

ROC.10:001

Rochester U. Inst. of Optics, N. Y.

EXCITED STATE WAVE FUNCTIONS, EXCITATION ENERGIES, AND OSCILLATOR STRENGTHS FOR

Ne ($2p^5 3s$), by A. Gold and R. S. Knox. Sept. 1958, 20p. incl. tables, refs. (Technical rept. no. 1) (AFOSR-TN-58-885) (AF 49(638)432; continuation of AF 18(600)688) AD 204101; PB 137156 Unclassified

Also published in Phys. Rev., v. 113: 834-839, Feb. 1, 1959.

Solutions of the Hartree-Fock equations for the $3P$ and $1P$ terms of neon ($2p^5 3s$) have been obtained. Wave functions are tabulated and results of computations of excitation energies and oscillator strengths are presented. The former fall within 10% of experimental values. It is found that enlarging the size of the "invariant core" used to compute the excited state wave functions has only a small effect on the predicted energies. The predicted oscillator strength of the 736A transition is 0.11, which is in reasonable agreement with available experimental data considering the large uncertainties in the measurements. The computed diamagnetic susceptibility of the ground state is $-7.4 \times 10^{-6} \text{ cm}^3 \text{ mol}^{-1}$, in good agreement with experiment. (Contractor's abstract)

ROC.11:001

Rochester U. Inst. of Optics, N. Y.

HOST SENSITIZED LUMINESCENCE IN KI:Tl, by K. Teegarden. Nov. 17, 1958 [11]p. incl. diagrs. (Technical note no. B-2) (AFOSR-TN-58-917) (AF 49-638)433; continuation of AF 18(600)193) AD 204563 Unclassified

Host sensitized luminescence has been observed in a single crystal of KI doped with about one part in 10^5 of thallium. The quantum efficiency of the thallium luminescence stimulated at room temperature by irradiation in the fundamental bands of KI was about 0.1. At 93°K the thallium luminescence is masked by the previously reported luminescence of undoped KI. Excitation and emission spectra for the room-temperature luminescence are given. (Contractor's abstract)

ROC.11:002

Rochester U. Inst. of Optics, N. Y.

TRAPPED CHARGE AND THE LOW TEMPERATURE LUMINESCENCE OF UNDOPED KI, by K. Teegarden and R. F. Weeks. Nov. 10, 1958 [17]p. incl. diagrs. (Technical note no. B-1) (AFOSR-TN-58-918) (AF 49-638)433) AD 204562; PB 137845 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 10: 211-216, July 1959.

New data is presented on the previously reported low temperature blue luminescence of undoped KI. It is shown that the emission previously observed during irradiation in the fundamental bands can also be stimulated by irradiation in the F. and F'-bands formed by exposure to ultraviolet light at 93°K. The crystals display a burst of red luminescence when warmed after irradiation with light absorbed in the fundamental bands at 93°K. No emission occurs upon irradiation in the F-band at 93°K if the F-centers have been formed at a temperature somewhat above that of the thermal burst of red luminescence. It is suggested that the red luminescence occurs when holes are released from V-centers during warming and the blue luminescence is due to the recombination of electrons with trapped holes at 93°K. (Contractor's abstract)

ROM.04:001

Rome U. School of Aeronautical Engineering (Italy).

THEORETICAL AND EXPERIMENTAL ANALYSIS OF COWLING CONFIGURATIONS FOR THE REDUCTION OF THE DRAG ON A BODY OF REVOLUTION WITH LARGE CONE ANGLE, by L. Broglio. June 1956, 47p. incl. illus. diagrs. (SIARgraph no. 7) (AFOSR-TR-57-2) (AF 61-514)816) AD 115053 Unclassified

The possibility of reducing the total drag of a pointed body of revolution with large cone angle, using the favorable interference of a cowling ring is proved. Theoretical computations by the method of characteristics have been performed for both cases of the body alone and the body with the cowling. Experimental results are shown and discussed for various configurations and shapes of the cowling. (Contractor's abstract)

ROM.02:002

Rome U. School of Aeronautical Engineering (Italy).

EXACT SOLUTION FOR CANTILEVER PLATES OF WHICHEVER TRAPEZIUM PLANFORM AND OF VARIABLE THICKNESS, by L. Broglio. May 1956, 75p. incl. diagrs. tables. (Technical note no. 1; SIARgraph no. 6) (AFOSR-TN-57-92) (AF 61(514)888) AD 120440 Unclassified

ROM.02:003 - ROM.02:008

The subject of this technical note is the static analysis of cantilever variable thickness plates of whichsoever trapezium planform. The general partial differential equations of the problem are reduced to an infinite series of ordinary equations: the solution is obtained by a chordwise expansion in powers of deflection. If the flexural rigidity of the plate is chordwise varying with any law, and spanwise varying with the law x^n , an exact solution is attained. All formulas providing the solution are given, and comparison is made, on numerical examples, between the various orders at which the chordwise expansion can be stopped. (Contractor's abstract)

ROM.02:003

Rome U. [School of Aeronautical Engineering] (Italy).

AN EXACT SOLUTION FOR FREE RECTANGULAR PLATES Laterally Loaded, by L. Broglio. Aug. 1958, 116p. incl. diagrs. tables. (Technical note no. 2; SIARgraph no. 8) (AFOSR-TN-57-288) (AF 61(514)888) AD 132359 Unclassified

The general problem of the rectangular free plate of constant thickness, under whichsoever load-distribution, is considered in this paper. It is firstly shown that (1) any given load distribution can be reduced to boundary loads and (2) that the complete solution is reached when six particular problems (symmetric or antisymmetric, moments or reactions, be prescribed by the boundary condition) are solved. The solution of each one of the six particular problems is then developed. A new procedure is here introduced. It consists in satisfying exactly one of the boundary conditions on the four sides; and then the other one by means of a system of linear equations, by methods of successive approximations of very good convergence. A numerical example developed for three plates of different aspect ratio shows the adequacy of the method, and the trend in the stress-distribution as aspect ratio increases. (Contractor's abstract)

ROM.02:004

Rome U. School of Aeronautical Engineering (Italy).

MODELING TECHNIQUE AND THEORY FOR AERO-ELASTIC SIMILARITY IN BLOW-DOWN WIND TUNNEL TESTS, by L. Broglio. Mar. 1958, 133p. incl. illus. diagrs. tables. (Technical note no. 3; SIARgraph no. 30) (AFOSR-TN-58-902) (AF 61(514)888) AD 204283; PB 137452 Unclassified

A general approach to solve similarity problems in aeroelastic phenomena for testing wing models and wing-tail combinations at the blowdown high pressure wind tunnel is presented. Theoretical methods and experimental devices to be used are reported. The results

of various series of tests at $M = 3.01$ and at two Reynolds numbers of $20 \cdot 10^8$ and $40 \cdot 10^6$ on a wing model and on a wingtail combination for 3 cases of different materials, with the same planform, are presented. A comparison with the theoretical values is also presented. (Contractor's abstract)

ROM.02:005

Rome U. School of Aeronautical Engineering (Italy).

SOME CONTRIBUTIONS TO THE HEAT CONDUCTION AND THERMAL STRESSES ANALYSIS IN AIRCRAFT AND MISSILE STRUCTURES, by L. Broglio. [1958] [48]p. incl. diagrs. refs. [Technical note no. 4; SIARgraph no. 40] (AFOSR-TN-58-1006) (AF 61(514)888) AD 206149; PB 139815 Unclassified

Presented at meeting of the First Internat'l. Congress in Aeronaut. Sciences, Madrid (Spain), Sept. 8-13, 1958.

Also published in Advances in Aeronaut. Sciences, v. 1: 213-235, 1959.

The analysis of temperature distribution for bodies subjected to kinetic heating and heat losses by radiation is discussed along with the case of boundary conditions, depending upon the time and upon surface temperature distributions. The simple solution for the concentrated heat source in a heterogeneous body of whatever shape is found is presented first. By considering a surface layer of timewise and spacewise variable heat sources, the so-called Q-solution is obtained. By combining the Q-solution with the boundary conditions, an integrodifferential equation with respect to time is obtained, which can be easily integrated step-by-step, despite its non-linear nature. The application of the theory to the hollow hemisphere and to the hollow semicylinder is then presented. It also contains, for sake of comparison, the solution of a classical two-dimensional problem, of rather difficult analytical solution, and an evaluation of thermal stresses. (Contractor's abstract)

ROM.02:006

Rome U. School of Aeronautical Engineering (Italy).

HEAT CONDUCTION IN SOLIDS AT HYPERSONIC SPEED, by L. Broglio. Oct. 1958 [27]p. incl. diagrs. table. (Technical note no. 5; SIARgraph no. 45; NATO AGARD rept. no. 209) (AFOSR-TN-58-1132) (AF 61(514)888) AD 207977; PB 142980 Unclassified

Presented at Eighth meeting of the AGARD Structures and Materials Panel, Copenhagen (Denmark), Oct. 20-25, 1958.

A simple formula is obtained which relates directly each series coefficient of the temperature to the

RCS.01:001 - RCS.01:003

corresponding series coefficient of the heat flow. In the field of nonlinear problems, special attention is paid to the heat conduction problem for a body whose thermal properties are changing with temperature. Such a problem, by means of a suitable change of variables, is reduced to a similar problem for the same body with constant thermal properties and whose solution is obtained. The results are applied to the problem of heat conduction at hypersonic speeds. An exact expression is found for the trajectory of the body in the atmosphere for the case in which gravity and centrifugal forces are neglected. (ASTIA abstract)

Rosemount Aeronautical Labs., Minneapolis, Minn.
see Minnesota U. Rosemount Aeronautical Labs.,
Minneapolis, Minn.

RCS.01:001

[Royal Coll. of Science and Tech. Dept. of Mathematics,
Glasgow (Scotland)].

A DIRECT METHOD OF USING THE HODOGRAPH PLANE IN FLUID DYNAMICS, by A. G. Mackie. [1957] 21p. (In cooperation with St. Salvator's Coll., St. Andrews (Scotland)) (AF 61(514)1170) Unclassified

Also published in Proc. Edinburgh Math. Soc., v. 11: 107-114, 1958/59.

A number of problems in 2-dimensional incompressible flow in which either the magnitude or the direction of the velocity is constant on sections of the bounding streamlines can be solved by means of the conformal mapping of the hodograph plane. In this study, these are regarded as real boundary value problems for the stream function ψ as a function of the velocity variables. In many cases the solution can be found with much less work than is involved in the use of the Schwarz-Cristoffel transformation. Further, this direct method can be extended immediately to solve analogous problems in compressible flow, whether the exact or approximate (transonic) equations of motion are used. General formulas are given for the position coordinates and for the drag. (Contractor's abstract)

RCS.01:002

Royal Coll. of Science and Tech. Dept. of Mathematics,
Glasgow (Scotland).

TWO-DIMENSIONAL SUBSONIC AND SONIC FLOW PAST THIN BODIES, by J. B. Helliwell and A. G. Mackie. Oct. 1957 [17]p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-58-111) (AF 61(514)1170) AD 152019 Unclassified

Also published in Jour. Fluid Mech., v. 3: 93-109, Oct. 1957.

Hodograph methods are applied to determine the flow at high subsonic and sonic velocities past two-dimensional, thin, symmetrical bodies. The boundary value problem for the determination of the stream function ψ , which in the present theory is a solution of Tricomi's equation, is simplified by the assumption of a free stream breakaway at sonic velocity from the shoulder of the body. A solution is obtained in terms of Bessel functions. The flow past a wedge of small angle is discussed and expressions are obtained for the pressure on the nose, the drag coefficient and the width of the wake. A comparison with the corresponding results in the case of sonic velocity derived by the more complex analysis of Guderley and Yoshihara (1950) shows that the present simpler theory yields very similar values for the pressure over the nose. The flow at sonic velocity past a profile which is a first-order perturbation upon a wedge profile is analyzed on the basis of the same free streamline theory. The flow pattern is obtained past an arbitrarily specified body by an application of the Hankel inversion theorem, and an expression is deduced for the drag. (Contractor's abstract)

RCS.01:003

Royal Coll. of Science and Tech. Dept. of Mathematics,
Glasgow (Scotland).

TWO-DIMENSIONAL FLOW PATTERNS AT HIGH SUBSONIC SPEEDS PAST WEDGES IN CHANNELS WITH PARALLEL WALLS, by J. B. Helliwell. Sept. 6, 1957 [22]p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-58-294) (AF 61(514)1170) AD 154203

Unclassified

Also published in Jour. Fluid Mech., v. 3: 385-403, Jan. 1958.

Investigations are made of the plane flow of an inviscid isentropic gas at high subsonic and sonic speeds past a finite wedge of small angle set at zero incidence in a channel with parallel walls. Hodograph methods are applied to the determination of the stream function, which, under the usual transonic approximation, is a solution of Tricomi's equation. A brief summary is given of the derivation of the fundamental solution of this equation in terms of Bessel functions. Two models of the flow pattern are discussed. The model of Cole is examined with the sonic line from the shoulder extending completely across the channel at right angles to the wall. The Helliwell-Mackie model is taken in which there is a free stream breakaway at sonic velocity from the shoulder of the wedge and the velocity far downstream may be either uniformly subsonic or sonic. Values are obtained for the drag coefficient in both cases and a high degree of both qualitative and quantitative agreement is found. On the basis of the free streamline theory explicit formulas are given relating, in terms of the channel width and upstream Mach number, the drag of the wedge in the channel to that of the same wedge in the free stream.

RCS.01:004-006; ROY.02:001

Attention is drawn to certain properties of plane jet flows that may be deduced from the investigation of the flow with free stream breakaway past a wedge in a channel. (Contractor's abstract)

RCS.01:004

[Royal Coll. of Science and Tech. Dept. of Mathematics, Glasgow (Scotland)].

THE CALCULATION OF THE DRAG IN PROBLEMS SOLVED BY THE HODOGRAPH METHOD, by A. G. Mackie. Feb. 1958 [3]p. (Technical note no. 3) (AFOSR-TN-58-604) (AF 61(514)1170) AD 162129
Unclassified

Also published in Philosophical Mag., v. 3: 140-142, Feb. 1958.

Explicit formulas are found for the total drag on a class of obstacles placed in a uniform stream of an inviscid fluid when the stream function is given in terms of the velocity variables. The formulas are given for incompressible flow and for the exact equation of compressible flow. (Contractor's abstract)

RCS.01:005

Royal Coll. of Science and Tech. Dept. of Mathematics, Glasgow (Scotland).

AN APPLICATION OF THE WEBER-ORR TRANSFORM TO THE PROBLEM OF TRANSONIC FLOW PAST A FINITE WEDGE IN A CHANNEL, by J. B. Helliwell. [1958] [5]p. incl. diagrs. [Technical note no. 4] (AFOSR-TN-58-1037) (AF 61(514)1170) AD 206486
Unclassified

Also published in Proc. Cambridge Philos. Soc., v. 54: 391-395, July 1958.

The flow around an angle placed symmetrically in a channel of constant width is treated, and the length of the sides of the angle is taken as finite. It is assumed that the flow line which follows one of the sides of the angle is continued by a jet line at constant velocity. The flow is subsonic everywhere, but the angle is small; and the velocities, at the upper infinity and at the lower infinity, are related to the critical velocity. It is possible to make a study legitimately within the framework of the theory of small perturbations of a transonic flow: one ought to look for a solution of a Tricomi equation in the plane of the hodograph suiting conditions with suitable limits. This method of solution is related to that of an integral equation that can be explicitly resolved in this case. (Math. Rev. abstract)

RCS.01:006

[Royal Coll. of Science and Tech. Dept. of Mathematics, Glasgow (Scotland)].

THE SOLUTION OF BOUNDARY-VALUE PROBLEMS FOR A GENERAL HODOGRAPH EQUATION, by A. G. Mackie. [Aug. 1958] 23p. refs. (In cooperation with St. Salvator's Coll., St. Andrews (Scotland)) (AF 61-514)1170) Unclassified

Published in Proc. Cambridge Philos. Soc. (England), v. 54: 538-553, Oct. 1958.

In this mathematical study, the solution is found for certain boundary-value problems appropriate to the flow of an inviscid, compressible fluid past a wedge-shaped profile. The most general hodograph equation in the form

$$\frac{\partial^2 \psi}{\partial \sigma^2} + k(\sigma) \frac{\partial^2 \psi}{\partial \theta^2} = 0 \quad \text{is used. Expressions are found for}$$

the position coordinates and the drag. The resulting solutions are then discussed for functions $k(\sigma)$ appropriate to Chaplygin's equation, Tricomi's equation, and the equation of Tomotik and Tamada. The case of Helmholtz flow past a wedge with sonic velocity upstream is treated in detail, and the resulting expressions for the drag enable an estimate to be made of the error which results in using approximations to Chaplygin's equation. (Contractor's abstract)

ROY.02:001

[Royal Inst. of Tech., Stockholm (Sweden)].

THE TRANSITION PROCESS AND OTHER PHENOMENA IN VISCOUS FLOW, by E. R. Lindgren. Jan. 1957, 169p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-290) (AF 61(514)1202) AD 132361
Unclassified

Also published in Arkiv för Fysik, v. 12: 1-169, 1957.

An account is presented of some experiments on the transition process and other phenomena of liquid flow, conducted mainly in cylindrical tubes using bentonite soils. Included are discussions on investigation of the properties of these bentonite soils; pressure-drop measurements and visual observations to confirm Schlieren's and Binnie's results on the transition from laminar to turbulent flow; visual studies of some effects of various protuberances in tube flow; simultaneous observations of the transition process at various pairs of locations along long cylindrical tubes; and studies of the onset of turbulence by means of simultaneous pressure-drop measurements at several locations along long cylindrical tubes.

ROY.02:002; RUT.04:001; RUT.01:003, 004

ROY.02:002

Royal Inst. of Tech., Stockholm [(Sweden)].

TURBULENT FLASHES, by E. Faxén. [1958] [2]p. incl. diags. [AF 61(514)1202] Unclassified

Published in Arkiv för Fysik, v. 13: 235-236, 1958.

A comment is given on the transition from toroidal vortices at inlet to a sequence of turbulent "flashes", moving with slightly less than the mean velocity of flow down a pipe of diameter 6 to 12 mm, with long stretches of laminar flow in between.

RUT.04:001

Rutgers U. Coll. of Engineering, New Brunswick, N. J.

EARLY DETECTION OF MICROCRACKS, by J. J. Slade, Jr. and A. Szrajer. Progress rept. no. 5, Dec. 1, 1957-Feb. 28, 1958. Mar. 14, 1958, 11p. diags. (AFOSR-TN-58-252) (AF 49(638)17) AD 154155 Unclassified

A general expression is given for the rocking curve associated with the $\vec{n} = [h, k, l]$ family of planes:

$$r(\vec{\beta}, \vec{n}) = A/(\beta_1^2 + \beta_2^2 + \beta_3^2) (\beta_2^2 + \beta_3^2) (\beta_3^2 + \beta_1^2).$$

Errors in the locations of the atoms are cumulative and are usually not known a priori. A scheme of computation is presented for expressing β_1 in terms of measurable quantities associated with the rocking curves. Elements of the Cauchy function are related to the moments of the truncated rocking curve. Finally, Ag single crystals, showing no substructure by the Lane method, have been selected for a preliminary investigation of rocking curves. They are being examined by a double crystal diffractometer.

RUT.01:003

Rutgers U. [Dept. of Mathematics] New Brunswick, N. J.

UNIQUENESS OF MULTIPLE TRIGONOMETRIC SERIES, by V. L. Shapiro. Jan. 31, 1957, 22p. (AFOSR-TN-57-51) (AF 18(600)1595) AD 115090

Unclassified

Also published in Ann. Math., v. 66: 467-480, Nov. 1957.

Two theorems are proved on the uniqueness of multiple trigonometric series. I. Given the multiple trigonometric series $(P) = \sum_m a_m e^{i(m,x)}$ where the a_m are arbitrary complex numbers; suppose that (1) $\sum_{R-1 < |m| \leq R} |a_m| =$

$o(R)$ as $R \rightarrow \infty$, (2) $f^*(x)$ and $f_*(x)$ are finite for all x , (3) $\bar{a}_m = a_{-m}$, and (4) $f_*(x) \geq A(x)$ where $A(x)$ is in L^1 on T_n ; then $f_*(x)$ is in L^1 on T_n and (P) is its Fourier series. II. Given the same series, let W be a set of measure zero on T_n and let q be a point on T_n not in W ;

suppose that (1) $\sum_{R-1 < |m| \leq R} |a_m| = o(R)$ as $R \rightarrow \infty$,

$f^*(x)$ and $f_*(x)$ are finite for x in $T_n - q$, (3) $f^*(x) = f_*(x)$ for x in $T_n - (W+q)$, and (4) $f_*(x)$ is in L^1 on T_n ; then (P) is the Fourier series of $f_*(x)$. T_n designates the

n -dimensional torus, $f^*(x) = \limsup_{t \rightarrow 0} \sum_m a_m e^{i(m,x) - |m|t}$

$= \limsup_{t \rightarrow 0} R(t) + i \limsup_{t \rightarrow 0} I(t)$, and $f_*(x)$ designates the corresponding $\lim_{t \rightarrow 0}$ as $t \rightarrow 0$. Theorem I is a direct analog of Verblunsky's (A. Zygmund, Trigonometric series, Warsaw, 1935, p. 297) theorem in one dimension, and is a best possible result. Theorem II is false in one dimension. Condition 1 cannot be changed to $O(R)$ as $R \rightarrow \infty$. In 2 dimensions this is illustrated by the Fourier-Stieltjes series of the measure on T_2 which has unit mass at the origin and is zero elsewhere.

RUT.01:004

Rutgers U. [Dept. of Mathematics] New Brunswick, N. J.

THE DIVERGENCE THEOREM WITHOUT DIFFERENTIABILITY CONDITIONS, by V. L. Shapiro. May 7, 1957, 3p. (AFOSR-TN-57-232) (AF 18(600)1595) AD 126529 Unclassified

Also published in Proc. Nat'l. Acad. Sciences, v. 43: 411-412, May 1957.

The differentiability conditions stated previously (On Green's Theorem, Jour. London Math. Soc. 1957) are eliminated. The results are true in k -dimensional Euclidean space, $k \geq 2$ when proper consideration is given to the boundary of the domain of the theorem. Let D_1 be an open set in the plane. Let $X = (x, y)$ and let $C(x, t)$ equal the circumference of the circle with radius t and center X ; define the divergence of the continuous vector field $V(X) = [A(X), B(X)]$ at the point X_0 in D_1 as the limit of $(\pi t^2)^{-1} \int_{C(X_0, t)} A dy - B dx$ as $t \rightarrow 0$ if this limit exists and is finite. Under these conditions the limit is $\text{div } V(X_0)$. Theorem: Let D be a bounded domain in the (x, y) -plane and let C be its boundary. Let E be a closed set of logarithmic capacity zero contained in $D + C$. Suppose that (1) the boundary consists of one of several simple closed rectifiable curves, (2) the

RUT.01:005, 006; RUT.03:002

vector field $V(X) = [A(X), B(X)]$ is defined and continuous in the closure $D = D + C$, (3) at each point X_0 of $D - DE$, $\text{div } V(X_0)$ exists, and (4) $\text{div } V(X)$ is Lebesgue integrable on D ; then $\int_C [A(X)dy - B(X)dx] = \int_D \text{div } V(X)dX$. The theorem is proved by observing that the following lemma in double trigonometric series holds: Let $A(X)$ and $B(X)$ be continuous periodic function of period 2π in each variable with respective

double Fourier series $\sum_M a_M e^{i(M,X)}$ and $\sum_M b_M e^{i(M,X)}$.

Let the vector field $V(X) = [A(X), B(X)]$; suppose $\text{div } V(X_0)$ exists and is finite; then $\lim_{z \rightarrow 0^+} \sum (ma_M +$

$nb_M) e^{i(M,X_0)} - |M|z = \text{div } V(X_0)$. $M = (m,n)$ represent the integral lattice points in the plane, $|M|^2 = m^2 + n^2$, and $(M,X) = mx + ny$.

RUT.01:005

Rutgers U. [Dept. of Mathematics] New Brunswick, N. J.

THE DIVERGENCE THEOREM FOR DISCONTINUOUS VECTOR FIELDS, by V. L. Shapiro. Sept. 11, 1957, 28p. incl. refs. (AFOSR-TN-57-569) (AF 18(600)-1595) AD 136554; PB 135089 Unclassified

Also published in Ann. Math., v. 68: 604-628, Nov. 1958.

The notation is as follows: $X = (x,y)$ and $C(X_0,t)$ is the circumference of the circle with center X_0 and radius t . $V(X) = [A(X), B(X)]$ is a continuous vector field in the neighborhood of X_0 , and

$$\text{div}^* V(X_0) = \limsup_{t \rightarrow 0} \frac{1}{\pi t^2} \int_{C(X_0,t)} A(X)dy - B(X)dx. A$$

similar definition is given for $\text{div}_* V(X_0)$. If $\text{div}_* = \text{div}^*$ is finite, this common value is $\text{div } V(X_0)$. D is a

bounded domain in the plane with a simple closed rectifiable curve C as its boundary, and Z is a closed set of measure zero contained in the interior of D . With respect to Z , the class of vector fields C_2 is

defined as follows: $V(X)$ is in C_2 if (1) $V(X)$ is continuous in $D + C - Z$, (2) $V(X)$ is in L^2 on D , (3) div_* and div^* are finite in $D - Z$, and (4) $\text{div } V(X)$ exists

almost everywhere in D and is in L^1 on D . Z is said to be a negligible set for the divergence theorem if V is in C_2 implies that the divergence theorem holds

for V with respect to D : $\int_C A(X)dy - B(X)dx =$

$\int_D \text{div } V(X)dX$. The principal result of the analysis is

the following theorem: A necessary and sufficient condition that Z be a negligible set for the divergence theorem is that Z be of logarithmic capacity zero.

RUT.01:006

Rutgers U. [Dept. of Mathematics] New Brunswick, N. J.

THE CONJUGATE FOURIER-STIELTJES INTEGRAL IN THE PLANE, by V. L. Shapiro. Oct. 27, 1958 [4]p. (AFOSR-TN-58-935) (AF 18(600)1595) AD 232552; PB 145741 Unclassified

Also published in Bull. Amer. Math. Soc., v. 65: 12-15, Jan. 1959.

The following theorem is proved: Let $K(x)$ be a planar Calderon-Zygmund kernel in class $Lip(\alpha, 2)$, $\frac{1}{2} < \alpha < 1$, and let $k(y)$ be its principal-valued Fourier transform. Let F be a countably additive set function defined on the Borel sets of the plane of finite total variation and let f be the Fourier-Stieltjes transform of F . Then

$$\int_{E_2} e^{-iy/R} \frac{1}{R} l(y,x) f(y) k(y) dy \text{ tends to a finite limit al-}$$

most everywhere as $R \rightarrow \infty$. (Contractor's abstract)

RUT.03:002

Rutgers U. Dept. of Physics, New Brunswick, N. J.

HIGH NEGATIVE NUCLEAR POLARIZATIONS IN A LIQUID, by L. H. Bennett and H. C. Torrey. Aug. 8, 1957 [7]p. incl. diagrs. (AFOSR-TN-57-488) (Also bound with its Eleventh Annual Research Report, Jan. 1, 1958) (AF 18(603)6) AD 136550 Unclassified

Also published in Phys. Rev., v. 108: 499-500, Oct. 15, 1957.

Negative nuclear polarizations of the proton spins of up to 65 times the equilibrium value were observed in a simultaneous nuclear magnetic resonance experiment where the electron spin resonance (ESR) was partially saturated in a solution of Na and naphthalene in 1,2-dimethoxyethane. This was named an inverted Overhauser effect (Phys. Rev., v. 92: 411, 1953). The ESR of the ionic free radical formed from an electron in the naphthalene solution was detected by means of an amplitude bridge at 500 mc in a steady field of 17.8 oer. In the same field the proton resonance of the solvent ether was observed at 76.8 kc with a modified Pound-Watkins spectrometer. Small sine wave modulation of the field at 200 c/sec provided the derivative of the absorption curve which was monitored by a phase sensitive lock-in detector. Simultaneously the ESR was partially saturated by the application of a large 50-mc voltage across a 2-turn coil. The experimental values of nuclear polarization were plotted as a function of the degree of saturation of the ESR. A very small degree of

RUT.03:003 - RUT.03:006

saturation of the ESR caused the depolarization of the nuclei. High saturation levels of ESR caused the proton polarization to increase in the negative direction. When negative polarization was achieved the detection of the NMR was by stimulated emission, indicating that the Overhauser effect could be used for a low-noise molecular amplifier. The observed saturation factor was plotted as a function of RMS. The computed value of s was 1.58×10^{-6} whereas the experimental value was 1.58×10^{-6} . These values are in good accord with the assumption that the protons can only relax to the lattice via their magnetic dipolar interaction with the free electron.

of states at or near the Fermi energy. It is believed that the second, positive part of the change in T_c is due to the increase in γ , and that the correlation between these quantities is in reasonable agreement with the recent theory of other investigators (Phys. Rev., v. 101: 939, 1956). During the course of the work a value of γ was obtained for pure tin which agrees well with a recent calorimetric result. Measurements of the residual resistance ratio of the samples show, as expected, that below the solubility limit this ratio increases linearly with impurity concentration with a slope which depends on the atomic radius of the impurity as well as on its valence.

RUT.03:003

Rutgers U. Dept. of Physics, New Brunswick, N. J.

SPIN AND SIZE OF Λ^0 PARTICLE, by K. Nishimura. [1957] [2]p. (AF 18(603)6) Unclassified

Published in Prog. Theoret. Phys. (Japan), v. 18: 665-666, Dec. 1957.

The spin of the Λ^0 particle has been predicted to be $1/2$ by an analysis of mesonic and non-mesonic decay of the Λ^0 hyperfragment. It is shown that by assuming a finite size for the Λ^0 particle, a higher spin can also be predicted. (Contractor's abstract)

RUT.03:005

Rutgers U. Dept. of Physics, New Brunswick, N. J.

DIFFUSION AND NUCLEAR SPIN RELAXATION IN WATER, by J. H. Simpson and H. Y. Carr. May 6, 1958, 7p. incl. diagr. table, refs. (AFOSR-TN-58-407) (AF 18(603)6) AD 158211 Unclassified

Also published in Phys. Rev., v. 111: 1201-1202, Sept. 1, 1958.

The diffusion coefficient and the spin lattice relaxation time of protons in ordinary water have been measured in the temperature range 0-100°C using nuclear magnetic resonance free precession techniques. Unlike previous diffusion measurements, the present values describe the diffusion of protons rather than foreign isotopes introduced as tracers. To within the experimental error the Stokes-Einstein relation adequately describes the relative temperature dependence of viscosity and diffusion, but above the vicinity of 40°C the spin lattice relaxation does not follow the viscosity in the predicted manner. (Contractor's abstract)

RUT.03:004

Rutgers U. Dept. of Physics, New Brunswick, N. J.

THE SUPERCONDUCTIVE CRITICAL TEMPERATURE AND THE ELECTRONIC SPECIFIC HEAT OF IMPURE TIN, by E. A. Lynton, B. Serin, and M. Zucker. [1957] [10]p. incl. diagrs. tables, refs. (Also bound with its Eleventh Annual Research Report, Jan. 1, 1958) (AF 18(603)6) Unclassified

Published in Jour. Phys. Chem. Solids, v. 3: 165-174, 1957.

From measurements of the threshold magnetic field as a function of temperature for specimens of tin containing 0.04 to 2.0 at.-% of various impurities the superconductive critical temperature, T_c , of these samples has been obtained, as well as the temperature coefficient, γ , of the electronic specific heat of the normal phase. It was found that the change in T_c produced by the impurities consisted of two parts. There is a decrease which is linearly proportional to the increase in residual resistance ratio and hence to the decrease in electronic mean free path. Superimposed on this decrease there is an increase in T_c . The results also showed that the measurable changes in γ are positive for all solutes, indicating a minimum in the density

RUT.03:006

Rutgers U. Dept. of Physics, New Brunswick, N. J.

STEADY-STATE FREE PRECESSION IN NUCLEAR MAGNETIC RESONANCE, by H. Y. Carr. Sept. 1, 1958 [23]p. incl. diagrs. refs. (AFOSR-TN-58-1052) (AF 18(603)6) AD 206984 Unclassified

Also published in Phys. Rev., v. 112: 1693-1701, Dec. 1, 1958.

A steady-state free precession technique for observing nuclear magnetic resonance is described. A mathematical analysis is presented for certain special conditions, and initial experiments verifying the results of this analysis are reported. This technique provides two opportunities for improving the signal-to-noise ratio. First, it provides a mechanism, similar to that of the "spin echo," for eliminating the effect of the

RUT.03:007 - RUT.03:010

inhomogeneity of the magnetic field on signal strength. This permits the effective use of larger samples. In the second place it provides a steady-state signal which can be observed with a narrow-band detector. Under certain conditions the technique has a broad response as a function of frequency or field. The upper limit to the width of this response is determined by the electronic apparatus supplying the rf pulses rather than the magnet or the nuclear sample. (Contractor's abstract)

RUT.03:007

Rutgers U. Dept. of Physics, New Brunswick, N. J.

BAND STRUCTURE OF GRAPHITE, by J. Slonczewski and P. R. Weiss. [1958] [8]p. incl. diagrs. tables, refs. (AF 18(603)6) Unclassified

Published in Phys. Rev., v. 109: 272-279, Jan. 15, 1958.

Tight binding calculations, using a two-dimensional model of the graphite lattice, lead to a point of contact of valence and conduction bands at the corner of the reduced Brillouin zone. A perturbation calculation which starts with wave functions of the two-dimensional lattice and is applied to the three-dimensional lattice is described. Some general features of the structure of the π -bands in the neighborhood of the zone edge are obtained and expressed in terms of appropriate parameters. (Contractor's abstract)

RUT.03:008

Rutgers U. Dept. of Physics, New Brunswick, N. J.

TEMPERATURE DEPENDENCE OF NUCLEAR SPIN RELAXATION IN WATER (Abstract), by J. H. Simpson and H. Y. Carr. [1958] [1]p. (AF 18(603)6) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 22, Jan. 29, 1958.

The activation energies E_R and E_D of nuclear spin relaxation T_1 and translational self-diffusion D have been obtained for protons in water using nuclear magnetic resonance free precession techniques. These energies have been compared with E_V , the activation energy of T/η where T is the absolute temperature and η is the viscosity. E_R , E_D , and E_V are equal and approximately constant in the region 5-25°C. The three values decrease in the region 35-55°C. E_R decreases at a rate greater than that of E_D and E_V . In the region 65-100°C, E_D and E_V are constant and equal just within the ex-

perimental error; however E_R , although constant, has a value 16% less than that of E_V . This difference is well outside the experimental error. This information provides a basis for re-examination of the theories of liquid structure, the Bloembergen-Pound-Purcell theory of relaxation, the Stokes-Einstein relation, and various properties of water having anomalies near 40°C.

RUT.03:009

Rutgers U. Dept. of Physics, New Brunswick, N. J.

THE LATTICE CONDUCTIVITY OF TIN, by M. Garfinkel and P. Lindenfeld. [1958] [5]p. incl. diagrs. tables, refs. (AF 18(603)6) Unclassified

Published in Phys. Rev., v. 110: 883-887, May 15, 1958.

The thermal conductivities of several impure tin specimens have been measured at liquid helium temperatures. Impurities of antimony, bismuth and indium between 0.1% and 6% were used to lower the electronic conductivity. The conductivities are found to be consistent with the equation $K = \alpha T + \beta T^2$, where the first term may be ascribed to the electronic conductivity and the second to the lattice conductivity. For impurities of 3% or less the values of α , combined with measurements of the residual electrical resistivity, agree to about one per cent with the prediction of the Wiedemann-Franz law. For the same samples β is approximately constant with a mean value of $3.5 \pm 0.4 \times 10^{-4}$ watts/cm deg³. The comparative constancy of this value of β indicates that it is characteristic of the intrinsic conductivity of the tin lattice. (Contractor's abstract)

RUT.03:010

Rutgers U. Dept. of Physics, New Brunswick, N. J.

POLARIZATION OF NUCLEONS ELASTICALLY SCATTERED BY NUCLEI, by K. Nishimura. [1958] [3]p. incl. diagrs. (AF 18(603)6) Unclassified

Published in Phys. Rev., v. 110: 1166-1168, June 1, 1958.

The polarization of 424 mev nucleons elastically scattered by nuclei is calculated by a method which is similar to the Born approximation but in which the phase shift of the incident plane wave due to the scattering potential is taken into consideration. A qualitative agreement with the experimental result is obtained if one uses the well parameters as determined by Riesenfeld and Watson. Poor agreement at the diffraction minimum may be attributed to the existence of inelastic scattering in the experimental data. (Contractor's abstract)

RUT.03:011-013; RUT.05:001

RUT.03:011

Rutgers U. Dept. of Physics, New Brunswick, N. J.

MAGNETIZATION CURVES OF IMPURE TIN SPECIMENS, by E. A. Lynton and B. Serin. [1958] [3]p. incl. diagrs. table. (AF 18(603)6) Unclassified

Published in Phys. Rev., v. 112: 70-72, Oct. 1, 1958.

As amplification of the measurements of the flux trapping in large impure tin cylinders, magnetization curves have been obtained in a transverse field for composite specimens made up of about fifty small tin cylinders. The size of these samples made it possible to anneal them well in a short time. In all cases in which the impurity concentration did not exceed the limit of solubility, there was no flux trapped once the external magnetic field was entirely removed. However, the shape of the magnetization curves indicates that flux does migrate out of the specimens as the external field is reduced. In one specimen in which the impurity concentration did exceed the limit of solubility, there was appreciable flux trapping even in zero field. (Contractor's abstract)

RUT.03:012

Rutgers U. Dept. of Physics, New Brunswick, N. J.

EFFECTS OF TRANSLATIONAL DIFFUSION ON NUCLEAR SPIN RELAXATION IN SIMPLE CONDENSED SYSTEMS, by H. C. Torrey. [1958] [6]p. incl. diagrs. (AF 18(603)6) Unclassified

Presented at Internat'l. Convention on Condensed States in Simple Systems, Varenna (Italy), Sept. 11-15, 1957.

Published in Nuovo Cimento, Series X, Suppl., v. 9: 95-100, 1958.

Methods are demonstrated for obtaining values for activation energies for the motion of protons in the hydrides of certain transition metals. Some results are given for $\text{PdH}_{0.64}$, $\text{Ti}_{1.77}$, and $\text{TaH}_{0.75}$.

RUT.03:013

Rutgers U. Dept. of Physics, New Brunswick, N. J.

CORRELATION OF ELECTRON WAVE FUNCTIONS IN METALS (Abstract), by P. R. Weiss and E. Abrahams. n.d. [1]p. (AF 18(603)6) Unclassified

The electron correlation function is defined as

$$g(\mathbf{r}', \mathbf{r}; E) = \sum_n \Psi_n^*(\mathbf{r}') \Psi_n(\mathbf{r}),$$

the sum being understood to be restricted to those values of n which belong to the particular energy E . The wave functions $\Psi_n(\mathbf{r})$ are proper functions of the Schrodinger equation. Particular interest in this function centers on how it is changed by the presence of impurities in metals. A free electron model of the metal is used to calculate the correlation averaged over all possible distributions of the locations of the impurities. The result is, when certain limiting conditions hold,

$$g(\mathbf{r}', \mathbf{r}; E) = p(E) \frac{\sin(2mE)^{1/2} |\mathbf{r}' - \mathbf{r}|}{|\mathbf{r}' - \mathbf{r}|} \exp(-|\mathbf{r}' - \mathbf{r}|/2\lambda),$$

where $p(E)$ is the density of states at E , and λ is a mean free path. This is just the result proposed by Bardeen; it is derived here from first principles. The essential limitation is that the density of the impurities be sufficiently small that certain multiple scatterings can be neglected. (Contractor's abstract)

RUT.05:001

Rutgers U. School of Chemistry, New Brunswick, N. J.

SENSITIZATION OF MERCUROS OXALATE BY DYES, by P. A. van der Meulen and R. H. Brill. Mar. 7, 1958 [7]p. incl. diagrs. tables. (Sponsored jointly by Squier Signal Lab., Fort Monmouth, N. J. under DA 36-039-sc-15560 and Air Force Office of Scientific Research under AF 18(600)1150) Unclassified

Published in Photographic Science and Engineering, v. 2: 121-127, Oct. 1958.

The adsorption of several sensitizing dyes by mercurous oxalate has been determined. The reflectance spectra of mercurous oxalate with adsorbed dye have been measured. Adsorption is often accompanied by a bathochromic shift of the absorption maxima. The best sensitizers found are Acriflavine, Acridine Orange, Acridine Yellow, and Proflavine; all are strongly adsorbed. Pyronin B and Acridine Red are weakly adsorbed and are feeble sensitizers. In the case of the phthalein dyes the order of sensitization is Erythrosin B > Eosin Y > Rose Bengal > Phloxin B. Erythrosin B, a better sensitizer than Eosin Y, is more strongly adsorbed; however, Rose Bengal does not sensitize as well as Eosin Y even though it is more strongly adsorbed. The cyanine dyes are not notably better sensitizers for mercurous oxalate than the other classes of dyes studied. In general, the spectral range of sensitization for mercurous oxalate by a given dye is virtually the same as the range for silver-halide emulsions. (Contractor's abstract)

STL.01:003, 007; STL.02:002, 003

STL.01:006

St. Louis U. [Dept. of Physics] Mo.

ON NEGATIVE ENERGY STATES IN APPROXIMATELY RELATIVISTIC WAVE EQUATIONS, by Z. V. Chraplyvy. Dec. 15, 1956, 1v. incl. tables, refs. (Technical rept. no. 4) (AFOSR- IN-57-29) (AF 18(600)789) AD 115064 Unclassified

Investigation is made to establish the role of negative energy states in nonrelativistic theory. The Foldy and Wouthuysen reduction method is used. A Dirac Hamiltonian is denoted by κ and the Foldy and Wouthuysen Hamiltonian by h_j . κ is a closed expression and h_j is an infinite series. The operator κ mixes the components of the spinor ψ ; the 4-component wave equation formed with h_j falls apart into two 2-component equations, one for ψ_1, ψ_2 and one for ψ_3, ψ_4 , and one of the pairs is omitted. The operator h_j is obtained from κ by a succession of canonical transformations. While uncoupling the 2 pairs of the ψ components, the Foldy-Wouthuysen method separates the positive-energy states from the negative-energy states, and the solution of the reduced equation deals with positive-energy states only. This assertion holds for free particles in a weak field. The degree of weakness can be determined by comparing h_j with some other operator which, when used as the Hamiltonian in a 4-component wave equation, prevents mixture to any degree of approximation. The Schrödinger procedure for the one-particle 2-particle cases is summarized, and applications to other Hamiltonians are worked out. In the case of the Breit Hamiltonian, the negative-energy states are not separated by the transformations, and in the case of the Bethe-Salpeter equation the energy states are completely removed. Differences in the 2 equations are discussed.

STL.01:007

St. Louis U. [Dept. of Physics] Mo.

CORRECTION TO THE LAMB SHIFT DUE TO PROTON CHARGE DISTRIBUTION (Abstract), by E. M. MacKinnon. [1957] [1]p. [AF 18(600)789] Unclassified

Presented at meeting of the Amer. Phys. Soc., Notre Dame U., South Bend, Ind., June 20-22, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 268, June 20, 1957.

Recent high-energy scattering experiments of electrons from protons in polyethylene indicate that the charge distribution of the proton can be represented by

$$4\pi\rho(r) = \frac{200}{3a_H^4} r \exp\left[-\frac{\sqrt{26}}{a_H} r\right], \quad a_H = (0.78 \pm 0.05)f.$$

The matrix element proper to the Lamb shift was re-

calculated using this charge distribution and suitably modified relativistic wave functions. This gives the result, $\Delta E_H = 1057.77 \pm 0.13$ mc, which is in agreement with experiment.

STL.02:002

St. Louis U. [Dept. of Physics] Mo.

QUASI-RESONANCE AND VARIOUS APPROXIMATIONS IN THE ANDERSON THEORY OF PRESSURE BROADENING (Abstract), by L. J. Kieffer and A. V. Bushkovitch. [1957] [1]p. [AF 18(600)1590] Unclassified

Presented at meeting of the Amer. Phys. Soc., St. Louis, Mo., Nov. 29-30, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 358, Nov. 28, 1957.

Because of the difficulty of applying the P. W. Anderson theory of pressure broadening, simplifications have been proposed. In a recent article by Perkins, Bushkovitch, and Kieffer a simplified theory was outlined in detail and applied to three cases of foreign gas broadening of linear molecules. This paper presents an analysis of this simplified theory and shows that it is equivalent to assuming that all partial cross sections for linear molecules are quasi-resonant and equal to quasi-resonant partial cross section for large J_2 . With this general

conclusion as a guide five common van der Waals interactions between linear molecules are examined, and a quantitative estimate of the errors involved in the use of the simplified theory is given.

STL.02:003

St. Louis U. [Dept. of Physics] Mo.

FOREIGN GAS PRESSURE BROADENING OF OCS (Abstract), by L. J. Kieffer and A. V. Bushkovitch. [1957] [1]p. [AF 18(600)1590] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 44, Jan. 30, 1957.

Previous calculations, using the Anderson theory, of the collision diameters of OCS with He, O₂, and N₂O, using the $J = 1-2$ line of OCS, were in reasonable agreement with experiment, and indicated that the perturbing molecule could be treated classically in the case of foreign gas broadening. Two new calculations also using the Anderson theory, have been carried out which support that assumption. The collision-diameter of OCS with O₂ has been recomputed treating the O₂ molecule classically but including terms which were dropped in the previous

STL.02:004; SAU.01.001, 002;
SMI.01:001, 002

calculation due to the complexity and apparent smallness of the terms. The new value 5.48A, is only slightly larger than that previously reported, 5.41A. In the second calculation the perturbing molecule was treated quantum-mechanically. Closed expressions were derived by S_2 and the partial cross section. The value obtained for the collision diameter was 5.61A which is within three percent of the value obtained treating the perturbing molecule classically.

STL.02:004

St. Louis U. Dept. of Physics, Mo.

CRITICAL ANALYSIS AND APPLICATIONS OF A QUASI-RESONANT THEORY OF PRESSURE BROADENING OF LINEAR MOLECULES, by L. J. Kieffer and A. V. Bushkovitch. [1958] [8]p. incl. tables. (AF 18-(600)1590) (Also bound in its AFOSR-TR-59-29; final rept.) Unclassified

Published in Jour. Molecular Spectroscopy, v. 2: 558-565, Dec. 1958.

A simplified Anderson theory of the pressure broadening of linear molecules has been critically analyzed and applied to five common types of molecular interactions. It has been shown that the simplified theory is equivalent to assuming that all partial cross sections of the exact Anderson theory are of the same order of magnitude as the resonant partial cross sections. Quantitative estimates of the errors introduced in the partial cross sections of the exact theory by making this simplifying assumption are given. (Contractor's abstract)

SAU.01:001

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

[VARIATIONS OF THE COSMIC RAYS AS A FUNCTION OF ITS ENERGY] Variaciones del los rayos cosmicos en funcion de su energia, by R. Armenteros, C. Uria, and D. Anda. [1958] [14]p. incl. diagrs. (AF 49(638)290) Unclassified

Published in Resumen de Labores, 1958, La Paz (Bolivia), Laboratorio de Fisica Cosmica, Dec. 1958, p. 20-23.

The E-W telescopes and electronics used are briefly described. Changes made in the equipment since it started operation in March 1957 are outlined with an account of the effects these changes had on the counting ratios. Preliminary pressure coefficients for 2 different geometries are reported, and time variation plots are included. (Contractor's abstract)

SAU.01:002

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

[INVESTIGATION OF OUR SHOWER DETECTORS AT HIGH ENERGY] Investigacion sobre chubascos extensos de alta energia, by J. Hersil and A. Lazo. [1958] [6]p. incl. diagrs. (AF 49(638)290) Unclassified

Published in Resumen de Labores, 1958, La Paz (Bolivia), Laboratorio de Fisica Cosmica, Dec. 1958, p. 25-28.

The giant shower detector using scintillation counters, which was recently installed at El Alto, is described. The sensitivity range of the equipment is evaluated and the various aims of the experiment are discussed. (Contractor's abstract)

Santa Barbara Coll., Goleta, Calif. see California U., Santa Barbara Coll., Goleta.

Sarah Mellon Scaife Radiation Lab., Pittsburgh, Pa. see Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

Sibley School of Mechanical Engineering, Ithaca, N. Y. see Cornell U. Sibley School of Mechanical Engineering, Ithaca, N. Y.

Sloane Physics Lab., New Haven, Conn. see Yale U. Sloane Physics Lab., New Haven, Conn.

SMI.01:001

Smith Coll. [Dept. of Chemistry] Northampton, Mass.

POTASSIUM AND COMPOUNDS, by G. S. Durham. [1957] [3]p. (AF 18(600)775) Unclassified

Published in Encyclopedia of Chemistry, N. Y., Reinhold, 1957, p. 778-780.

A presentation of the atomic, physical and chemical properties; isolation; and uses of potassium are given. The means of production of and the uses of the most important commercial compounds of potassium are also noted. Finally, methods of detection of potassium are offered.

SMI.01:002

Smith Coll. Dept. of Chemistry, Northampton, Mass.

THE EVALUATION OF LATTICE INTERACTIONS IN OR NEAR A CUBIC CRYSTAL, by G. S. Durham and B. A.

SIT.01:001 - SIT.01:004

Soderberg. Jan. 1958 [15]p. incl. table. (AFOSR-TN-58-55) (AF 18(600)775) AD 148096 Unclassified

Also published in Jour. Chem. Phys., v. 28: 1201-1206, June 1958.

Procedures, based on the methods of Madelung, have been developed for the evaluation of lattice sums of inverse-power particle-interactions, λa^{-n} , at any point in or near a cubic crystal. Although not as elegant mathematically as those of Hove and Krumhansl, they are more complete in including the important cases of a point near a plane or line of particles, and are sufficiently simple in principle to be understood and applied by anyone with a background in differential calculus. Applications to a face-centered cubic ionic crystal are discussed and, as an example, the dipole-dipole van der Waals energy of a chloride ion before a NaCl half-crystal is calculated. (Contractor's abstract)

SIT.01:001

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

OBSERVATIONS ON ABLATION AND METALLURGICAL EFFECTS PRODUCED BY SURFACE HEATING OF THE ALGOMA METEORITE, by R. R. O'Neil. Sept. 24, 1957 [9]p. incl. illus. diagrs. (Technical rept. no. 1) (AFOSR-TN-57-541) (AF 18(600)1596) AD 136529
Unclassified

The Algoma meteorite, found in 1887 near Algoma, Wis., was cut and examined macroscopically and microscopically. The meteorite is an example of an ablated tabular discoid or shield shape meteorite. The discoid iron approaches an ellipse with major and minor axes of 22 and 14 cm, respectively; the average thickness is 2 cm. Macroscopic observations indicated a Widmanstätten pattern, swathing kamacite enclosing schreibersite inclusions, and zones of plessite. Microscopic examination revealed Neumann bands, oxide scale, taenite lamellae, and fields of plessite. The following cumulative observations were made after examining the meteorite macroscopically and microscopically: (1) the concave face shows effects of ablation to a lesser degree than the convex face, (2) a 0.1-mm-thick zone of thermal alteration on the convex face probably was a thin layer of flowing molten material in flight, (3) the convex face was the leading face in flight, (4) the curvature of the meteorite is due to ablation and not bending, and (5) a minimum value of 10% of the original mass was lost in ablation.

SIT.01:002

Smithsonian Inst. Astrophysical Observatory
(Cambridge, Mass.)

IMPACT EFFECTS AND TEKTITES, by J. S. Rinehart.

Oct. 30, 1957, 10p. incl. refs. (Technical rept. no. 2) (AFOSR-TN-57-659) (AF 18(600)1596) AD 136652
Unclassified

Presented at Conf. on the Problems of Tektites, Nat'l. Acad. Sciences, Washington, D. C., June 17-18, 1957.

Also published in Geochimica et Cosmochimica Acta, v. 14: 287-290, 1958.

Data on the composition, form and distribution of tektites are examined in the light of knowledge of high speed impact phenomena to see how strong the evidence is for an impact origin. It is concluded that tektites could be of impact origin, but the arguments are inconclusive. A strong argument against such an origin is the lack of nickel-ferrous materials within the tektite. (Contractor's abstract)

SIT.01:003

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

DYNAMICAL LIMITS ON A LUNAR ORIGIN FOR TEKTITES, by C. M. Varsavsky. Nov. 20, 1957 [23]p. incl. diagrs. tables, refs. (Technical rept. no. 4) (AFOSR-TN-57-697) (AF 18(600)1596) AD 136690
Unclassified

Presented at Conf. on the Problems of Tektites, Nat'l. Acad. Sciences, Washington, D. C., June 17-18, 1957.

Also published in Geochimica et Cosmochimica Acta, v. 14: 291-303, 1958.

Theories regarding the origin of tektites are reviewed and it is proposed that the moon is the most likely source for these objects. Detailed calculations show that the Whipple-Rinehart model for the ejection of tektites from the moon makes it possible to reproduce their observed distribution over the earth's surface. (Contractor's abstract)

SIT.01:004

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

METEOR DISTRIBUTION AND CRATERING, by J. S. Rinehart. Oct. 28, 1957 [23]p. incl. illus. diagrs. table. (Technical rept. no. 3) (AFOSR-TN-57-700) (AF 18(600)1596) AD 136693; PB 132976
Unclassified

Also published in Proc. Second Hypervelocity and Impact Effects Symposium, Naval Research Lab., Washington, D. C. (May 22-24, 1957), Washington, Naval Research Lab., v. 1: 45-53, Dec. 1957.

SIT.01:005 - SIT.01:007

Three classes of extraterrestrial material that reach the earth are discussed. These include (1) interplanetary dust, (2) debris from comets, and (3) meteorites or fragments of planets which once resided between Mars and Jupiter. Estimates of the quantity of material falling to the earth vary from 1 to 10,000 tons per day. The concepts of energy, momentum, and the quality of failure which are considered basic to terminal ballistics are defined. Some practical problems are outlined which concern (1) the possible penetration of the hulls of spaceships, satellites, and intercontinental ballistic missiles by meteoric particles, (2) the effects of surface erosions, and (3) possible damage to equipment. Suggestions for future experimentation include an increase in efforts to detect, identify, and describe meteoric material, an extension of impact studies to higher and higher velocities, and an investigation of the physical processes that operate during meteoric impact.

SIT.01:005

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

ORIGIN OF DEEP ELLIPSOIDAL PITS ON LARGE IRON METEORITES, by R. R. O'Neil and J. S. Rinehart. Dec. 12, 1957 [10p. incl. diagrs. tables. (Technical rept. no. 5) (AFOSR-TN-57-752) (AF 18(600)1596) AD 136741 Unclassified

Large Fe meteorites frequently are morphologically marked by deep ellipsoidal pits, contrasting sharply with the broad shallow pits which are generally attributed to the ablation of the meteorite as it passes through the atmosphere. The Carbo meteorite is morphologically marked by 7 pits, all ellipsoids. On the Quinn Canyon meteorite there are 22 pits, excluding the base which was not presented on the plaster cast from which these observations were made. The major axes of each of the 2 groups of ellipsoidal pits were essentially parallel, and casual inspection of other large Fe meteorites, viz, Canyon Diablo and Grant, showed a similar parallelism of pits. Pit plots on a stereographic net indicated a preferred direction of orientation of the major axes of the ellipsoidal pits of both the Carbo and Quinn Canyon meteorites. It was considered doubtful whether severe local ablation could generate pits all similarly directed, for the axes of these pits are variously inclined to the meteorite surface. No casual relationship exists between direction of air flow and pit axis. Carbo is known to contain large ellipsoidal shaped inclusions of troilite, FeS, a compound whose melting point is below that of Fe. From observation on sections of the meteorite, these nodules are known to be aligned. Quinn Canyon also contains troilite, but reports have not discussed their alignment. There appeared to be little doubt but that the deep pits had their genesis in troilite nodules which were suddenly exposed as a consequence of ablation of material from

the meteorite. Whether the troilite melted out during the flight or eroded out after the meteorite came to rest could not be decided with certainty.

SIT.01:006

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

NEUMANN BANDS IN STONY-IRON METEORITES, by R. R. O'Neil and J. S. Rinehart. Dec. 12, 1957 [7p. incl. illus. (Technical rept. no. 6) (AFOSR-TN-57-753) (AF 18(600)1596) AD 136742 Unclassified

The microstructure of the bits of Fe that occur within stony-Fe meteorites was investigated with a view toward interpreting their mechanical history. Polished and etched sections of stony-Fe meteorites were observed microscopically for mechanical twins (Neumann bands), deformed twins, and evidence of slip. These sections were cut from meteorites obtained from: (1) the Yatoor, India; (2) Tomhannock, N. Y.; (3) Weston, Conn.; (4) Udipi, India; and (5) Vaca Muerta, Chile. Lamellae that had the appearance of Neumann bands developed in the Fe grains of all except the Vaca Muerta meteorite. The 4 specimens with lamellae all revealed a mirror image relationship between the lamellae and the surrounding Fe when etch pits were developed. In addition to etch pits, etch facets and what appeared to be slip lines were further evidence of mechanical strain. In many of the Fe grains, the Neumann bands had a pronounced curvature. In their virgin state, Neumann bands are straight. It was therefore concluded that the grains had been subjected to severe mechanical stresses subsequent to the formation time.

SIT.01:007

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

ABLATION OF METEORITES (Abstract), by J. S. Rinehart. [1957] [1]p. [AF 18(600)1596] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 45, Jan. 30, 1957.

A meteorite enters the earth's atmosphere at high velocity (8 km/sec to 70 km/sec), suffers rapid loss of material through aerodynamic heating and abrading forces, but survives passage and finally comes to rest on the ground. The ablation of high-velocity missiles is a most complex fluid dynamics problem. Post mortem examination of meteorites can suggest salient aspects of the problem. Surface features of a large number of meteorites have been studied. Very little can be said about the total amount of material lost. Meteorite

SIT.01:008 - SIT.01:011

size and material are critical factors. Small (up to 3 in. in diam) meteorites are smoothly sculptured; large stones exhibit shallow elongated pits or depressions (2 cm by 1 cm by 5 mm deep); and large irons, very deep pits (5 cm in diam and 3 cm deep). The number, distribution, and size of the depressions on a particular surface or portion of surface depends upon how the surface element is oriented with respect to the direction of flight. Pronounced irregularities of shape increase ablation. Finally, heat from the surface penetrates at most only a few millimeters into the meteorite.

SIT.01:008

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

METEORITIC MATTER AT THE PLACE OF FALL
OF THE TUNGUSKA METEORITE, by A. A. Yavnel, tr.
by F. W. Wright and P. W. Hodge. Feb. 19, 1958 [9]p.
incl. illus. (Technical rept. no. 7) (AFOSR-TN-58-244)
(AF 18(600)1596) AD 154146 Unclassified

Also published in Soviet Astron., v. 1: 769-772, Sept.-
Oct. 1957 (trans. of Astronomicheskii Zhur., v. 34: 794-
796, July 20, 1957).

In an attempt to shed some light on the nature of the composition of the Tunguska meteorite, which fell in the Siberian taiga in 1908, investigations were made of surface and subsurface soil samples taken from the region of fall. Visual observation of the samples indicated that the material consisted basically of black crystals of magnetite amalgamated with rock. In addition, tiny particles of three types were found: (1) metallic particles of silvery-white color, resembling minute grooved petals and scrolls, reminiscent of chips of the size of tenths of mm in length; (2) oxidized metallic particles somewhat brick-shaped with maximal dimensions up to several mm; and (3) black shiny spherules, consisting apparently of magnetite, 30-60 μ in diam. Spectra analysis of all except the spherules revealed that the "chips" contained 7% nickel and 0.7% cobalt, and the oxides - 4% nickel and 0.3% cobalt. The data obtained indicated that the metal particles have a composition typical of an iron meteorite and are different from artificial iron alloys. Comparison of the data with results of the soil investigation at the place of fall of the Sikhote-Alin meteorite shows great similarity.

SIT.01:009

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

METEORITES AND BALLISTICS, by J. S. Rinehart.
Apr. 21, 1958, 1v. incl. illus. diagrs. tables, refs.
(Technical rept. no. 8) (AFOSR-TN-58-354) (AF 18-
(600)1596) AD 154259 Unclassified

Also published in Selected Topics on Ballistics, Cranz
Centenary Colloquium, Freiburg U. (West Germany)
(Apr. 21-25, 1958), London, Pergamon Press, 1959,
p. 88-116.

A meteorite enters the earth's atmosphere at high velocity (11 km/sec to 72 km/sec), is subjected to powerful aerodynamic forces, suffers rapid loss of material through aerodynamic heating and abrasion, but occasionally survives passage and finally may strike the ground, producing an impact crater. The phenomena involved in these encounters of a meteorite with our atmosphere and our lithosphere are ones commonly met with in ballistic studies. For example, the surface features of a number of aerodynamically sculptured meteorites are germane to the complex ballistics problem of ablation of high velocity missiles. Meteorites striking the earth have produced the largest known impact craters and contribute significantly to the physics and chemistry of high speed impact. This paper discusses recent studies in the inter-related areas, meteoritics, ballistics, and astrobballistics, with specific reference to ablation fundamentals, the shapes and surface features of various meteorites, and the nature of impact craters. (Contractor's abstract)

SIT.01:010

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

EVIDENCE ON THE NATURE OF AIRFLOW AROUND
STONY METEORITES IN FLIGHT, by E. P. Henderson
and D. T. Williams. Apr. 29, 1958, 1v. incl. illus.
diagrs. (AFOSR-TN-58-436) (AF 18(600)1596)
AD 158240 Unclassified

The flow markings on the surface of a series of stony meteorites were photographed and rationalized in the light of simple aerodynamic theory. Complete agreement between theory and experiment was demonstrated as relating to the orientation of the objects during flight, and separation of flow from bluff objects near the edges. The pits which are universally observed characteristics of meteorites showed flow lines inside. Some of the meteorites showing no flow lines were identified as being oriented in flight by other characteristics, leading to the conclusion that flow lines are not a unique indicator of non-tumbling flight. (Contractor's abstract)

SIT.01:011

Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.

SILICATE METEORITE STRUCTURES AND THE ORIGIN
OF THE METEORITES, by J. A. Wood, Jr. June 19,
1958, 165p. incl. illus. diagrs. tables, refs. (Technical
rept. no. 10) (AFOSR-TN-58-547) (AF 18(600)1596)
AD 158364 Unclassified

SIT.02:001; SFE.01:001; SCU.02:001;
SCU.03:001, 002

The petrography (particularly textures) and petrology of stony meteorites were studied as a key to the origin, evolution, and constitution at depth of the earth. Classifications, textures and mineralogy, and chemical compositions of numerous meteorites are given as well as 19 microphotographs. Discussions on the solar system evolution and the condensation of the chondrules included topics on (1) currently considered hypotheses for the formation of the solar system, (2) stellar temperatures and pressures, (3) effect of rotations, (4) phase equilibria, (5) adiabatic cooling, (6) condensation processes, (7) chondrule-dust fractionation, (8) optical measurements of Fe content of olivine in chondrites, and (9) accretion. The classification, mineralogy, textures, and chemical compositions of nonchondrites are presented and the relation of nonchondrites to chondrites is discussed. The topics covered in a discussion of parent meteorite planets encompassed: (1) a review of the central-melting model; (2) enstatite chondrites and aubrites, (3) the stony-irons, ureilites; (4) howardites and breccias, (5) shergottites, (6) mesosiderites, (7) occluded gases and the carbonaceous chondrites, and (8) amphoterites. (ASTIA abstract)

SIT.02:001

[Smithsonian Inst. Astrophysical Observatory,
Cambridge, Mass.].

PROCEEDINGS OF THE THIRD SYMPOSIUM ON COSMICAL GAS DYNAMICS, Smithsonian Astrophysical Observatory, Cambridge, Mass. (June 24-29, 1957), ed. by J. M. Burgers and R. N. Thomas. [1958] [204]p. incl. illus. diagrs. tables, refs. (I.A.U. Symposium series no. 8; Smithsonian Symposium publication no. 1) (Sponsored jointly by Air Force Office of Scientific Research, Internat'l. Union of Theoret. and Appl. Mech., Internat'l. Astronom. Union, UNESCO, and National Science Foundation) Unclassified

Published in Rev. Modern Phys., v. 30: 905-1108,
July 1958.

This symposium was attended by over 30 scientists, 24 of whom came from outside the United States, and about 60 from this country. Among the main topics discussed were the production of velocity fields, the origin of interstellar gas clouds, and dissipation mechanisms operative in large scale velocity fields. At the final session of the symposium a special discussion lead to the unanimous recommendation that these meetings be continued.

SFE.01:001

Société Française d'Études et de Réalisations
d'Inventions Coand'. Clichy (France).

[THE COANDA EFFECT] PARTS I-III. Final rept.

[1958] 3v. incl. illus. diagrs. tables. (AFOSR-TR-58-135a,b,c) (AF 61(514)1049) AD 204073; AD 204074; AD 204075 Unclassified

A detailed study is presented of the theoretical and experimental aspects of the Coanda effect. The objectives of this research were (1) to define the physico-mathematical and experimental characteristics of the whole Coanda effect; (2) to verify experimentally its application to Coanda nozzles; and (3) to investigate the possible utilization of the "effect" in the design and construction of Lenticular aerodynes.

SCU.02:001

South Carolina U. Dept. of Chemistry, Columbia.

NEW PRODUCTS FROM THE REACTION OF BENZOYL PEROXIDE WITH BENZENE, by D. F. DeTar and R. A. J. Long. June 13, 1958, 3p. (AFOSR-TN-58-602) (AF 49(538)88) AD 162127; PB 138983 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 4742-4743, Sept. 5, 1958.

The thermal decomposition of benzoyl peroxide in benzene in a nitrogen atmosphere has been found to produce two new products, which are tetrahydroquaterphenyl and dihydrobiphenyl. The phenylcyclohexadienyl radical is shown to be an intermediate in the biphenyl formation. The production of biaryl products in a solvent such as nitrobenzene is believed to depend on the conditions of: (a) the relative rates of formation of the isomeric substituted phenylcyclohexadienyl radicals, and (b) the subsequent possible differing rates of these radicals.

SCU.03:001

South Carolina U. Dept. of Electrical Engineering,
Columbia.

NON-WAVEGUIDE TRANSMISSION OF MILLIMETER WAVES, by R. G. Fellers and W. E. Propst. Apr. 15, 1957 [18]p. incl. illus. diagrs. refs. (AFOSR-TN-57-188) (AF 18(603)43) AD 126483 Unclassified

An investigation is discussed of the use of free space transmission between a pair of appropriately spaced and designed radiators as a possible replacement for waveguide transmission within a millimeter wavelength system. (Contractor's abstract)

SCU.03:002

South Carolina U. Dept. of Electrical Engineering,
Columbia.

NON-WAVEGUIDE METHODS OF MILLIMETER WAVE TRANSMISSION, by R. G. Fellers. [1957] [15]p. incl. illus. diagrs. (AF 18(603)43) Unclassified

SCU.03:003; SCU.01:002, 003

Published in Proc. First Tri-Service Millimeter Wave Symposium, Army Signal Engineering Labs., Fort Monmouth, N. J., Sept. 10-11, 1957, p. 25-39.

One difficulty encountered in the use of millimeter wavelengths is the excessive attenuation of rectangular dominant-mode waveguide in this frequency range. Several possible solutions to the high attenuation problem have been proposed and are discussed. The use of a dielectric-rod waveguide in a hybrid dipole mode has been investigated by Chandler and Elsasser of the RCA Labs. By selection of a rod small in diam in terms of wavelength very low attenuation can be obtained. Such a small diam rod is characterized by fields which extend far beyond the rod and requires exciters of large dimensions. Under this low-loss condition radiation occurs from bends in the guide. It appears from these difficulties that one of the principal uses of dielectric rods is in a flexible waveguide of moderate attenuation where the field is virtually confined to the interior of the rod. The circular hollow pipe waveguide in the TE_{01} mode shows much promise as a low loss transmission medium. Experiments have indicated that extremely low loss can be obtained, i.e., several decibels per mile. Some problems have arisen due to the TM_{11} mode which is produced in bends and similar irregularities, but has been eliminated in part by using waveguides made of a helix or of annular rings imbedded in lossy material. Some difficulty has also been encountered in the design of a satisfactory broad-band compact launcher for this mode, but it still appears that this approach has much to recommend it. As an alternative to either of the above schemes, it is suggested that a free space system of transmission be utilized within radar or communications installations to replace a waveguide transmission system.

SCU.03:003

South Carolina U. Dept. of Electrical Engineering, Columbia.

A CIRCULAR POLARIZATION DUPLEXER FOR MILLIMETER WAVES, by R. G. Fellers. Nov. 1, 1958, 12p. incl. illus. diagrs. (AFOSR-TN-58-771) (AF 18-603)43 AD 201774, PB 138740 Unclassified

Also published in Trans. Amer. Inst. Elec. Engineers, v. 78 (Part I): 934-937, Jan. 1960.

A circular-polarization duplexer is described for use in the millimeter wavelength range. Such a duplexer finds its field of application in any system which utilizes the same antenna for simultaneous transmission and reception, as for example, a continuous-wave radar. The millimeter wavelengths are here defined as covering the range from 1 to 10 mm (frequency range 30,000 to 300,000 mc).

SCU.01:002

South Carolina U. [Dept. of Mathematics] Columbia.

SYSTEMS OF LINEAR DIFFERENCE EQUATIONS AND SYSTEMS OF LINEAR DIFFERENTIAL EQUATIONS WHICH SATISFY CONDITIONS AT TWO POINTS, by T. Fort. Apr. 1957, 8p. (AFOSR-TN-57-174) (AF 18(603)-23) AD 126469 Unclassified

The difference equations:

$$y_k(i+1) = a_{k1}(i)y_1(i) + a_{k2}(i)y_2(i) + \dots + a_{kn}(i)y_n(i)$$

for $1 \leq k \leq n$, are defined to be representable in the following matrix form $\Gamma(i+1) = M(i)\Gamma(i)$. The i and k are limited to integral values and the $a_{st}(i)$ are defined when $0 \leq i \leq b$. The solution of the set of equations is a set of functions, $y_1(i), y_2(i), \dots, y_n(i)$ which satisfy the equations at all points of $0 \leq i \leq b$. No gain in generality is found if $0 \leq i \leq b$ is replaced by $a \leq i \leq b$. It is shown that there exists one and only one solution of the set of difference equations taking on arbitrary prescribed values at 0. A set of analogous differential equations is studied by the use of a similar form of analysis.

SCU.01:003

South Carolina U. [Dept. of Mathematics] Columbia.

LINEAR DIFFERENCE AND DIFFERENTIAL EQUATIONS SATISFYING CONDITIONS AT MORE THAN ONE POINT, by T. Fort. Technical rept. June 1957, 9p. (AFOSR-TN-57-307) (AF 18(603)23) AD 132378 Unclassified

Also published in Proc. Amer. Math. Soc., v. 9: 287-292, Apr. 1958.

Investigation is made of linear difference and differential equations which satisfy conditions at more than one point. Sufficient conditions on the coefficients are given so that a solution of a system of linear equations exists which consists of a set of functions, some of which take on prescribed values at one point, and others at other points. The approach to differential equations is through difference equations. The system of difference equations

$$\text{considered is } y_v(i+1) = \sum_{\mu=1}^n a_{v\mu}(i)y_{\mu}(i), \text{ where } v =$$

$1, \dots, n$; i is limited to integral values, and the coefficients $a_{v\mu}(i)$ are defined when $0 \leq i \leq b$. The set of differential

$$\text{equations considered is } \frac{dy_v}{dx} = \sum_{\mu=1}^n g_{v\mu}(x)y_{\mu}, \text{ where } v =$$

$1, \dots, n$, and the $g_{v\mu}(x)$ are continuous over the integral $0 \leq x \leq 1$.

SCU.01:004 - SCU.01:007

SCU.01:004

South Carolina U. [Dept. of Mathematics] Columbia.

A PROBLEM OF RICHARD BELLMAN, by T. Fort.
 Technical rept. Aug. 1957, 5p. (AFOSR-TN-57-542)
 (AF 18(603)23) AD 136530 Unclassified

Also published in Proc. Amer. Math. Soc., v. 9: 282-286, April 1958.

Given the Sturm-Liouville problem (1) $u'' + \lambda [f(x) + \epsilon g(x)]u = 0$, (2) $u(0) = u(1) = 0$, where $f(x)$ and $g(x)$ are continuous functions over $[0, 1]$ with positive minima, and where λ_1 is regarded as the smallest characteristic value as a function of ϵ : determine whether λ_1 is an

analytic function of ϵ for $R(\epsilon) \geq 0$, and locate the singularity nearest the origin ($\epsilon=0$) (R. Bellman, Bull. Amer. Math. Soc., Jan. 1957). The method of differences is used. Regard $f(x)$ and $g(x)$ defined as continuous functions $-n \leq x \leq 1+n$ where $n > 0$ is arbitrarily small; assume $|f(x)| < N$, $|g(x)| < N$, where N is constant. Let $x_1 = 0, 1/n, 2/n, \dots, 1$ and consider

the difference equation (3) $n^2 \Delta^2 y(x_1) + \lambda [f(x_1) + \epsilon g(x_1)]y(x_{1+1}) = 0$ side by side with (1). The following theorems are proved: I. Let $u(x, \lambda, \epsilon)$ be a solution of (1) where $u(0, \lambda, \epsilon) = 0$ and $\frac{\partial}{\partial x}(0, \lambda, \epsilon) = 1$; let $y(x, \lambda, \epsilon)$ be a solution of (3) such that $y(0, \lambda, \epsilon) = 0$ and $n \Delta y(0, \lambda, \epsilon) = 1$; then when $n \rightarrow \infty$, $y(x, \lambda, \epsilon)$ approaches $u(x, \lambda, \epsilon)$ uniformly in x, λ, ϵ so long as $0 \leq x \leq 1$, $|\lambda| < M$, $|\epsilon| < M$, where M is a constant but otherwise arbitrary. Moreover, $u(x, \lambda, \epsilon)$ and $y(x, \lambda, \epsilon)$ are each expressible as power series in λ , where, when $n \rightarrow \infty$, the coefficients of the various powers of λ in the series for y approach uniformly the coefficients of like powers of λ in the power series for u . II. The function $\lambda_1 = X(\epsilon)$ obtained from $u(1, \lambda_1, \epsilon) = 0$ for real ϵ can be analytically extended over any finite region not including the negative axis of reals; its singularity nearest the origin is $\min(-\frac{f(x)}{g(x)})$ when x is on $[0, 1]$.

SCU.01:005

South Carolina U. [Dept. of Mathematics] Columbia.

LIMITS OF THE CHARACTERISTIC VALUES FOR CERTAIN BOUNDARY-VALUE PROBLEMS ASSOCIATED WITH DIFFERENCE EQUATIONS, by T. Fort. [1957] 11p. incl. table. (AF 18(603)23) Unclassified

Published in Jour. Math. and Phys., v. 35: 401-407, Jan. 1957.

The difference equation $\sum_{v=1}^{\mu} \Delta_{i_v} \{k_v(i_1, i_2, \dots, i_{v-1}, i_{v-1}, i_{v+1}, \dots, i_{\mu}) \cdot \Delta_{i_v} y(i_1, i_2, \dots, i_{v-1}, i_{v-1}, i_{v+1}, \dots, i_{\mu})\} + \left[\frac{\lambda}{n} - s(i_1, i_2, \dots, i_v, \dots, i_{\mu}) \right] y(i_1, i_2, \dots, i_v, \dots, i_{\mu}) = 0$.

It is assumed that i_1, i_2, \dots, i_{μ} are limited to integral values and that k and s are defined when $0 \leq i_q \leq m_q$, $q = 1, 2, \dots, \mu$ and that $k > 0$, $s > 0$. The point set for the fundamental domain is associated with an equation for each of the points. Boundary conditions for the y values on the boundary of the fundamental domain give m homogeneous linear equations in m variables. The characteristic equation, represented by the determinant of coefficients equated to zero so as to investigate the solutions, is solved as an equation in $\frac{\lambda}{n}$ and the roots are considered as characteristic values for the problem.

SCU.01:006

South Carolina U. [Dept. of Mathematics] Columbia.

PARTIAL LINEAR DIFFERENCE EQUATIONS, by T. Fort. [1957] [7]p. (AF 18(603)23) Unclassified

Published in Amer. Math. Monthly, v. 64: 161-167, Mar. 1957.

In abbreviated notation, the equations studied are of the form

$$\sum \{k_{ab}(i, j)y(i+a, j+b) : (a, b) \in P\} = R(i, j), (i, j) \in S,$$

where P is a given finite set of ordered pairs of integers, and $R(i, j)$, as well as $k_{ab}(i, j)$ for each $(a, b) \in P$, is a given function of (i, j) whose domain S is the set of all integral points in a fixed rectangle. Particular attention is paid to the case where P is the "five-point pattern" $\{(-1, 0), (0, -1), (1, 0), (0, 1), (0, 0)\}$. The domain of a solution y is the set $\{(i+a, j+b) : (i, j) \in S; (a, b) \in P\}$. Auxiliary linear conditions, usually boundary conditions, are sometimes imposed. In this context, consideration is given to the concepts of fundamental domain, fundamental system of solutions, compatibility of a system, and Green's function.

SCU.01:007

South Carolina U. [Dept. of Mathematics] Columbia.

ON CONVERGENT PERTURBATION EXPANSIONS, by R. Bellman and T. Fort. May 1958, 5p. (AFOSR-TN-58-205) (AF 18(603)23) AD 152238; PB 134659

Unclassified

SCU.01:008, 009; SCU.04:001; SOC.02:007

It is shown that an expansion of the form

$$\Lambda(\epsilon) = \sum_{n=0}^{\infty} \lambda_n h_n(\epsilon)^n,$$

convergent for $\epsilon \geq 0$, can be obtained for the smallest characteristic value of the Sturm-Liouville equation

$$u'' + \lambda (f(x) + \epsilon g(x))u = 0, \quad u(0) = u(1) = 0,$$

under the assumption that $f(x)$ and $g(x)$ are continuous functions in $0 \leq x \leq 1$ satisfying the conditions $f(x), g(x) \geq a^2$. (Contractor's abstract)

SCU.01:008

South Carolina U. [Dept. of Mathematics] Columbia.

A LINEAR DIFFERENTIAL EQUATION WHOSE COEFFICIENTS INVOLVE q-PERIODIC FUNCTIONS, by T. Fort. May 1958, 3p. (AFOSR-TN-58-364) (AF 18(603)23) AD 154269 Unclassified

The general solution to an n-th order, linear equation whose coefficients are of the form $z^k p_{n-k}(z)$ is given in terms of a power series solution which explicitly takes into account the q-periodicity of the coefficients, $p_j(qz) = p_j(z)$. The solution is

$$\sum_{j=1}^k \sum_{v=0}^{\alpha_j-1} c(\log z)^v F_k(z),$$

where the $F_j(qz) = \rho_j F_k(z)$, the α_j are the multiplicity of the ρ_j terms, and the constant c depends on both j and v.

SCU.01:009

South Carolina U. [Dept. of Mathematics] Columbia.

A PROBLEM IN LINEAR DIFFERENTIAL EQUATIONS, by T. Fort. July 1958, 5p. (AFOSR-TN-58-619) (AF 18(603)23) AD 162148 Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 300-303, Apr. 1959.

Given the equation $u'' + (1 + \lambda g(x))u = 0$ with $\int_0^1 |g(x)| dx < \infty$ with $u_1(x)$ as the solution of this equation with the initial data $u_1(0) = 0$, and $u_1'(0) = 1$. It is known that $u_1(x) \sim r(\lambda) \sin(x + \theta(\lambda))$. Following a suggestion of Bellman, the dependence of the analytic properties of $r(\lambda)$ and $\theta(\lambda)$ on the complex parameter λ have been studied. It is shown that $r(\lambda)^2$ is an entire function

and that $\cos \theta(\lambda)$ is analytic and regular except at the points where $r(\lambda) = 0$. This is done by considering first an analogous problem for a difference equation and then passing to the limit.

SCU.04:001

South Carolina U. [Dept. of Physics] Columbia.

STUDIES OF POSITRON LIFETIMES IN SOLIDS by A. P. French and A. R. Lowrey. Final rept. 1958, 55p. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-63) (AF 49(638)74) AD 158241 Unclassified

The purpose of this work was to study the effect of an internal electric field on the mean lifetime of positrons in a ferroelectric material. The internal electric field can effectively be "turned on or off" by raising or lowering the samples' temperature above or below the Curie temperature. A fast coincidence circuit (resolving time approximately 3 nusec) was assembled. The components not commercially available were constructed and the equipment was calibrated. Decay curves were run for several materials, some of which have been previously studied, (aluminum, teflon, polyethylene, and plexiglas). The results compare favorably with measurements obtained by others. The decay curve was run for Rochelle Salt, a ferroelectric crystal with an internal field of approximately 800 esu between the temperatures 255°K and 297°K. Several measurements were taken with the sample above the critical temperature of 297°K, and the lifetime was found to consist of one component, $\tau_1 = (5.25 \pm 0.25) \cdot 10^{-10}$ sec. (Contractor's abstract)

SOC.02:007

Southern California U. Dept. of Chemistry, Los Angeles.

DERIVATIVES OF SULFENIC ACIDS. XXIX [a]. THE CHARACTERIZATION OF CERTAIN STEROLS WITH 2,4-DINITROBENZENESULFENYL CHLORIDE, by R. B. Langford and N. Kharasch. [June 1957] [6]p. incl. table. (AFOSR-TN-57-295) [AF 18(600)844] AD 132366 Unclassified

Also published in Jour. Org. Chem., v. 22: 1673-1675, Dec. 1957. (Title varies)

The pyridine-catalyzed reactions of 2,4-dinitrobenzenesulfonyl chloride (I) with testosterone, 19-nortestosterone, 17-methyltestosterone and 11- α -hydroxyprogesterone are described. Evidence is presented for the conclusion that the products are sulfonate esters, formed by the reactions of I with the alcohol functions. It is suggested that these reactions, coupled with chromatographic separations of mixtures of the derivatives and regeneration of the sterols from the esters, which

SOC.02:008; SOC.03:003, 004; SOC.04:004, 005

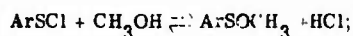
has been achieved, may prove of value in isolation studies in this field of work. The synthesis of octadecyl 2,4-dinitrobenzenesulfonate is also reported. (Contractor's abstract)

SOC.02:008

Southern California U. Dept. of Chemistry, Los Angeles.

STUDIES OF THIOPEROXIDES (SULFENATE ESTERS), by N. Kharasch. Final rept. Sept. 1, 1953-Dec. 31, 1956, 1v. (AFOSR-TR-57-23) (AF 18(600)844) AD 120492 Unclassified

The mechanism is investigated of the reaction of a representative aromatic sulfonyl chloride with the simplest alcohol (methanol), i.e., the reaction:



New examples of sulfonyl esters are synthesized via the sulfonyl chloride alcohol reaction; New routes are sought to synthesize thioperoxides; Studies are initiated of the chemical and physical properties of sulfenate esters; New areas of interest are explored related to the synthesis and chemistry of sulfenate esters, especially those involving their thioperoxidic character.

SOC.03:003

Southern California U. Dept. of Chemistry, Los Angeles.

RESOLUTION, STEREOCHEMICAL CORRELATION, AND MAXIMUM ROTATIONS OF THE NORBORNANE- AND 5-NORBORNENE-2-CARBOXYLIC ACIDS. ISOTOPE DILUTION AS AN AID IN THE DETERMINATION OF OPTICAL PURITY, by J. A. Berson and D. A. Ben-Efraim. [1958] 18p. incl. refs. (AFOSR-TN-58-1097) (AF 18(600)1544) AD 207591 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 4083-4087, Aug. 5, 1959.

endo-Norbornanecarboxylic acid (1a) has been resolved via the cinchonidine salt. The active acid has been stereochemically correlated with the exo-isomer and with endo- and exo--5-norbornene-2-carboxylic acids. The optical purity of 1a and of the other three acids have been established by application of the isotope dilution technique of Graff, Rittenberg and Foster. (Contractor's abstract)

SOC.03:004

Southern California U. Dept. of Chemistry, Los Angeles.

THE STEREOCHEMISTRY OF THE PERBENZOIC AND OXIDATION OF OPTICALLY ACTIVE EXO-ACETYL-

NORBORNANE, by J. A. Berson and S. Suzuki. [Dec. 1958] [28]p. incl. diagrs. refs. (AFOSR-TN-58-1131) (AF 18(600)1544) AD 207976 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 4088-4094, Aug. 5, 1959.

(-)-exo-Acetylnorbornane of known optical purity is prepared by the sequence (-)-exo-norbornanecarboxylic acid - acid chloride - (-)-ketone. The optical rotation of enantiomerically pure exo-norbornyl acid phthalate is established by analysis of a partially resolved sample for enantiomer content by isotope dilution of exo-

norbornyl acid phthalate- C^{14} . Combination of this result with data of Winstein and Trifan affords rotations of enantiomerically pure exo-norborneol and exo-norbornyl acetate. Perbenzoic acid of the active ketone gives exo-acetate with 94.2-100% retention of optical purity, indicating less than 2.9% attack at C.1. The implications of the results for an understanding of the type of hybridization in the transition state of 1,2-rearrangements is discussed. (Contractor's abstract)

SOC.04:004

Southern California U. Dept. of Chemistry, Los Angeles.

THE TIME LAG IN DIFFUSION II, by H. L. Frisch. Oct. 1957 [19]p. incl. diagrs. table. (Technical rept. no. 4) (AFOSR-TN-57-235) (In cooperation with Bell Telephone Labs., Murray Hill, N. J.) (AF 18(603)122) AD 126532 Unclassified

Also published in Jour. Phys. Chem., v. 62: 401-404, Apr. 1958.

It is shown that provided one knows or can guess the functional form of the concentration dependence of the diffusion coefficient, measurements of the time lag in (vacuum) transmission experiments through a membrane at several diffusant reservoir pressures (or concentrations) allows us to determine both the diffusion coefficient (and its parameters) as well as the solubility of the diffusant in the membrane. Under some weak restrictions, even if nothing is known concerning the functional dependence, a knowledge of the time lag allows one to estimate the order of magnitude of the integral diffusion coefficient. (Contractor's abstract)

SOC.04:005

Southern California U. Dept. of Chemistry, Los Angeles.

A NUMERICAL APPROACH TO THE PROBLEM OF SEDIMENTATION VOLUME, by M. J. Vold. Aug. 1958, 9p. incl. tables. (Technical rept. no. 5) (AFOSR-TN-58-843) (AF 18(603)122) AD 203333; PB 137051 Unclassified

SOC.04:006, 007; SOC.06:001; SOC.05:002

Methods of computation of the sediment volume, which is to be utilized as a quantitative criterion of particle interaction, are presented along with some results for spherical particles and for simulated rod-like particles built of aggregates of spheres. The computational scheme was found adaptable for obtaining the sediment volume and sediment structure for a wide variety of particle shapes and assumed mechanics of particle interaction. The simplest type of interaction, rigid cohesion on first contact between particles, appeared to apply accurately to systems of glass spheres in nonpolar media containing small amounts of water. In addition to packing volume, the computational scheme leads to information about the structure of the sediment which may be useful in the estimation of interparticle forces. In the model investigated the number of multiparticle contacts diminished noticeably as the size distribution widened. (ASTIA abstract)

SOC.04:006

Southern California U. Dept. of Chemistry, Los Angeles.

[COLLOID STATISTICS], by H. L. Frisch. Final rept. Aug. 1958, 3p. (AFOSR-TR-58-77) (AF 18(603)122) AD 158344 Unclassified

Work under the contract centered around 3 general aspects: (1) relaxation times in dilute systems, (2) phase transformations in colloidal systems, and (3) gelation theory. Experiments were performed to determine the time lag in the nucleation of second phase colloids. In the study of gels it was assumed that: (1) they are formed by growing networks of rigid ovaloids at a certain critical concentration strongly influenced by the ratio of radii of the ovaloids, and (2) that the density difference between the gel particles and the solvent is zero, eliminating the effect of gravity. The spontaneous growth of the network is then treated in first approximation as if it were a mathematical tree in analogy with the Flory gelatin theory of polyfunctional condensation polymers.

SOC.04:007

Southern California U. Dept. of Chemistry, Los Angeles.

AN APPROACH TO EQUILIBRIUM, by H. L. Frisch. [1958] [8]p. incl. refs. (In cooperation with Bell Telephone Labs., Murray Hill, N. J.) [AF 18(603)122] Unclassified

Published in Phys. Rev., v. 109: 22-29, Jan. 1, 1958.

The concept of statistical equilibrium of an isolated mechanical system is modified to mean a state in which the observable local macroscopic properties such as the local density of particles, mean energy, temperature, entropy, etc., have attained their equilibrium values, i.e., the values which would be obtained

from the density in phase space which corresponds to the appropriate stationary solution of Liouville's equation. The approach to equilibrium in time in this sense (i.e., for the local properties which are suitable averages over the action variables of the system) of a wide class of multiply periodic systems is demonstrated under the condition that a local property exists initially. The question of extension of this ergodic result to less restricted mechanical systems has been discussed and the relationship to ergodic theory and coarse graining indicated. The general transport theory and the approach to spatial uniformity of a sufficiently ideal gas are investigated by using as a model a gas of elastic hard-sphere molecules with vanishing diameter. In particular it is shown that under suitable conditions the diffusion in density satisfies Fick's laws and the conduction of heat satisfies Fourier's law, albeit with time-dependent transport coefficients. (Contractor's abstract, modified)

SOC.06:001

Southern California U. Dept. of Chemistry, Los Angeles.

DERIVATIVES OF SULFENIC ACIDS. XXXII. STUDIES OF THIOPEROXIDES. PART 4. REACTIONS OF TRICHLOROMETHANESULFENYL CHLORIDE WITH 1,2-EPOXIDES AND ALCOHOLS, by R. B. Langford and N. Kharasch. [1958] [7]p. incl. table, refs. (AFOSR-TN-58-428) (AF 49(638)330) AD 158231 Unclassified

Trichloromethanesulfonyl chloride (I) reacts with 1,2-epoxides and with meso-butadiene dioxide to form beta-chloroalkyl trichloromethanesulfonates. The reaction is catalyzed by t-amines and identical products are obtained by substituting appropriate beta-chloro alcohols for the epoxides. The results agree with the mechanism which postulates trans opening of the epoxide rings, as previously suggested for the similar reactions of 2,4-dinitrobenzenesulfonyl chloride. The new products from reaction of I with epoxides and certain alcohols are reported. (Contractor's abstract)

SOC.05:002

Southern California U. Engineering Center, Los Angeles.

A METHOD OF ALLEVIATING THE EFFECTS OF THE BOUNDARY LAYER SHOCK-WAVE INTERACTION AT COMPRESSION CORNER, by J. C. Williams, III. May 31, 1958, 46p. incl. illus. diags. (USCEC rept. no. 40-202) (AFOSR-TN-58-344) (AF 18(600)1145) AD 158248 Declassified

Experimental results are presented which indicate that the undesirable effects of boundary layer separation at a compression corner in supersonic flow can be reduced by a slight modification of the body geometry just ahead of the corner. This modification consists of introducing a rearward facing step of small depth and of moderate length just ahead of the corner. The experimental

results show that the pressure distribution after the compression corner (an inclined wedge in this case) is improved and that the length of forward influence of the separated region, due to the corner, is decreased by this simple change in geometry. Improvements such as these have direct application to the design of deflected control surfaces and ramp (or spike) type diffusers. The present investigation was carried out at a Mach number of 2.54 in the University of Southern California Supersonic Wind Tunnel Facility. (Contractor's abstract)

SOC.05:003

Southern California U. Engineering Center, Los Angeles.

LOW-DRAG SPECIFICATION OF SURFACE IRREGULARITIES, by J. W. Stuart, Jr. Mar. 31, 1958, 13p. incl. diagrs. (USCEC rept. no. 40-203) (AFOSR-TN-58-404) (AF 18(600)1145) AD 158207 Unclassified

By a re-interpretation of the experimental results on boundary-layer transition by Tani and Dryden readily useable nomographs are obtained which can be utilized for engineering purposes.

SOC.05:004

Southern California U. Engineering Center, Los Angeles.

ON THE LAMINAR BOUNDARY LAYER WITH ARBITRARY PRESSURE GRADIENT AND WALL TEMPERATURE DISTRIBUTIONS, by J. C. Williams, III. July 31, 1958, 17p. incl. diagr. (USCEC rept. no. 40-204) (AFOSR-TN-58-583) (AF 18(600)1145) AD 162103 Unclassified

The laminar boundary layer equations for a compressible heat conducting gas are first transformed by the Stewartson transformation. The transformed equations are then attacked by the Blasius series procedure which is well known in incompressible boundary layer theory. This procedure yields a number of pairs of simultaneous ordinary differential equations which, when solved, define the boundary layer on a body with an arbitrary pressure distribution. The method also allows for an arbitrary wall temperature distribution or an arbitrary heat transfer rate distribution along the body. The resulting equations can probably best be solved on modern high speed computing machines. (Contractor's abstract)

SOC.05:005

Southern California U. Engineering Center, Los Angeles.

AN INVESTIGATION OF SHOCK WAVE-BOUNDARY LAYER INTERACTION, by R. L. Chuan. Aug. 1958, 32p. incl. illus, diagrs. (USCEC rept. no. 40-101) (AFOSR-TN-58-145) (AF 18(600)1145) AD 302753 Declassified

An experimental study is made of the strong interaction between a boundary layer and a supersonic inviscid outer flow in the vicinity of a compression corner. Attempts are made to assess the validity of certain assumptions made in the Crocco-Lees theory of interaction. A simple method is devised, on the basis of the experimental findings, for the control of a laminar boundary layer upstream of a compression corner. (Contractor's abstract)

SOC.07:001

Southern California U. Engineering Center, Los Angeles.

INVESTIGATION OF SUPERSONIC DIFFUSER INSTABILITY, by A. C. Brown. Final rept. Nov. 30, 1956, 1v. incl. illus, diagrs. (USCEC rept. no. 41-101) (AFOSR-TR-57-1) (AF 18(600)1167) AD 115038 Unclassified

Investigation of the unstable flow through four different types of diffuser has been made. These were a pitot type intake, an axisymmetric model with a center body, a ramp and a scoop intake. The pitot was unique in that its only instability was at low and zero mass flow, and was of the acoustic organ pipe type. The other intakes were characterized by a high frequency oscillation at low mass flows, and a more complex phenomenon, known as buzz, at higher mass flows. It is believed that all diffusers which have a surface ahead of the inlet will have these two types of oscillation present to some degree, and that they will be of the form described in this report. The high frequency oscillation was caused by over-blowing of the fundamental organ pipe frequency due to higher energy content of the air flow past the lip for these three intakes. The buzz phenomenon can be broken down, for analysis purposes, into four phases, of which the second is the high frequency oscillation associated with low mass flows. The first is a statically divergent forward movement of the shock wave, whose origin has not yet been determined, the third is a rapid rearward movement of the normal shock from a position well forward of the lip to a supercritical position, and the final phase of the cycle is a slow relaxation of the shock wave to its original position. (Contractor's abstract)

SOC.07:002

Southern California U. Engineering Center, Los Angeles.

FURTHER COMMENTS ON "SUPERSONIC DIFFUSER INSTABILITY", by C. L. Dailey. [1957] [2]p. [AF 18-(600)1167] Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 70-71, Jan. 1957.

R. L. Trimpi's comments on "Supersonic Diffuser Instability" are discussed. The specific references to

SOC.08:001 - SOC.08:005

Trimpi's views on buzz and to points made by C. L. Dailey (Supersonic Diffuser Instability, Jour. Aeronaut. Sciences, v. 22: 733-749, Nov. 1955) are sufficiently pointed out.

SOC.08:001

Southern California U. Engineering Center, Los Angeles.

A STUDY OF THE CONDENSATION OF NITROGEN BELOW THE TRIPLE POINT, by R. L. Chuan. Feb. 28, 1957, 11p. incl. diagrs. (USCEC rept. no. 56-201) (AFOSR-TN-57-19) (AF 18(603)95) AD 115052
Unclassified

An analysis was made of the theoretical investigation of the rate of deposition of solid nitrogen on a cooling surface in order to obtain design criteria for the condensing chamber of the two-phase wind tunnel. Results indicate that it is possible to solve the integral equation characterizing the process through the use of experimental data obtained from a study made at the A. D. Little Lab., and that the mass-flow requirements of the tunnel can be met with a condensing surface area of about 60 sq ft for runs lasting up to ten hr.

SOC.08:002

Southern California U. Engineering Center, Los Angeles.

PLASMA HEATING OF HYPERSONIC GAS FLOW, by R. L. Chuan. Dec. 31, 1957, 21p. incl. illus. (USCEC rept. no. 56-202) (AFOSR-TN-57-762) (AF 18(603)95) AD 136751
Unclassified

Presented at meeting of the Fluid Dynamics Div. of the Amer. Phys. Soc., Lehigh U., Bethlehem, Pa., Nov. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 288, June 19, 1958.

For the production of condensation-free hypersonic flow in a wind tunnel it is proposed to add energy to the electrons in the air downstream of the throat by high frequency electrodeless discharge, and allow electron energy to go into random kinetic energy of the molecules in the decay process. Previous work in this respect has dealt only with the discharge process, measuring the energy that can be added to the plasma by various types of discharges. The present work examines the decay processes in an attempt to channel as much of the electron energy as possible into raising the temperature of the gas, by preventing losses by ambipolar loss mechanism. Inhibition of ambipolar diffusion by means of an axial, constant magnetic field is examined, as well as the attendant possibility of having such an inhibiting effect nullified by drain diffusion resulting from hydromagnetic instability. An experimental investigation is being initiated. (Contractor's abstract)

SOC.08:003

Southern California U. Engineering Center, Los Angeles.

PRELIMINARY RESULTS OF PLASMA HEATING OF HIGH SPEED AIR FLOW, by R. L. Chuan. July 31, 1958, 8p. incl. illus. diagr. table. (USCEC rept. no. 56-203) (AFOSR-TN-58-650) (AF 18(603)95) AD 162182; PB 138109
Unclassified

The decay of a plasma formed by a radio-frequency discharge in a supersonic air stream is utilized to heat the latter. Preliminary experiments show the method to be feasible; and a stagnation temperature in the neighborhood of 1200°K is attained in an airstream at Mach number 3.5. (Contractor's abstract)

SOC.08:004

Southern California U. Engineering Center, Los Angeles.

A STUDY OF THE FEASIBILITY OF THE DIRECT CONDENSATION OF A SUPERSONIC STREAM, by H. Wong and J. C. Williams, III. July 31, 1958, 29p. incl. illus. diagrs. tables. (USCEC rept. no. 56-204) (AFOSR-TN-58-712) (AF 18(603)95) AD 162247
Unclassified

A pilot model wind tunnel was designed and developed for study of the possibility of using direct condensation (into a liquid) of a supersonic jet to sustain flow in a wind tunnel. The tunnel, using ethyl alcohol as the working fluid and liquid nitrogen as the coolant, was designed for M = 3, stagnation pressure of 4.0 mm Hg, and stagnation temperature of 357°K. (Contractor's abstract)

SOC.08:005

Southern California U. [Engineering Center] Los Angeles.

PLASMA HEATING OF SUPERSONIC AIRSTREAM, by R. L. Chuan. [1958] [1]p. incl. diagr. [AF 18(603)95]
Unclassified

Published in Phys. Fluids, v. 1: 452, Sept.-Oct. 1958.

A small experimental apparatus has been assembled to ascertain the feasibility of using the decay of a rf discharge-formed plasma to transfer energy to a supersonic air stream. The apparatus, shown schematically, consists of a glass Laval nozzle, rf electrodes surrounding it and a dc magnetic field coil producing a longitudinal field of 1000 gauss in the flow. The magnetic field is intended to reduce ambipolar diffusion of charge carriers to the nozzle wall, so as to allow a maximum of volume recombination within the gas flow to effect heating of the gas.

STR.02:001, 002; STR.03:001, 002

STR.02:001

Stanford Research Inst. Menlo Park, Calif.

THE ABSORPTION SPECTRA OF HILL REACTION OXIDANTS, by R. J. Marcus, J. L. Hatchett, and K. M. Sancier. June 11, 1957, 15p. incl. diagrs. tables, refs. (Rept. no. 6; technical note no. 1) (AFOSR-TN-57-304) (AF 18(603)7) AD 132375 Unclassified

Presented at Symposium on Photochemical Storage of Energy, Dedham, Mass., Sept. 3-7, 1957.

Also published in Science, v. 127: 647-648, Mar. 21, 1958.

The absorption spectra of eight Hill reaction oxidants were examined, and compared to the absorption spectra of nine compounds which are inactive in the Hill reaction. These spectra showed that all compounds which are Hill reaction oxidants absorb light at wavelengths corresponding to the blue absorption peak of chlorophyll. Cobaltioxalate, whose Hill reaction activity was predicted on the basis of this correlation, has been shown to be a good electron acceptor. Further work on this problem has led to the conclusion that the oxidation-reduction potential is not the only factor influencing Hill reaction activity of various electron acceptors. An additional factor appears to be the matching of electronic levels of chlorophyll (electron donor) and of the oxidant (electron acceptor) which is required of electron transfer reactions by the Franck-Condon principle. This apparent additional restriction on the choice of Hill reaction oxidants should be useful in the search for additional compounds which will store energy in the course of their Hill reaction activity.

STR.02:002

Stanford Research Inst., Menlo Park, Calif.

A NEW ELECTRON ACCEPTOR FOR THE HILL REACTION, by J. L. Hatchett and R. J. Marcus. [1958] [6]p. incl. diagr. tables. (AFOSR-TN-58-147) (AF 18-603)7) AD 152174 Unclassified

Also published in Arch. Biochem. and Biophys., v. 76: 233-234, July 1958.

Results are shown herein of typical Hill reaction runs using K cobaltioxalate as an electron acceptor. Experiments varied both with temperature and pH. A summary is given of the concentration dependence of the Hill reaction rate when cobaltioxalate is used as oxidant. Since CO_2 is evolved when cobaltioxalate is reduced in acid solution, some runs were performed in the presence of KOH. No significant change occurred.

STR.03:001

Stanford Research Inst., Menlo Park, Calif.

MASS SPECTROMETER STUDIES OF ALKALI METAL CHLORIDE VAPORS, by T. A. Milne, H. M. Klein, and D. Cubicciotti. Feb. 1958 [5]p. incl. table, refs. (Technical note no. 1) (AFOSR-TN-58-148) (AF 49(638)89) AD 152175 Unclassified

The importance of polymers in the ionized vapor phase of solid-vapor alkali metal systems has been studied to clarify conflicting results reported elsewhere. Five alkali-chloride salts were used and it was observed that dimer alkali complexes were present in each case while trimer complexes were observed for LiCl and NaCl. It has been found that the stabilities of the dimers increases uniformly with decreasing atomic number of the cation. A method has been proposed to study the relationship between measured ion intensities and molecular concentrations of the species in the vapor. A two-temperature Knudsen cell is employed to produce equilibrium polymer vapors. The intensities of the n types of polymer ion beams are measured at each of n temperatures for the top part of the Knudsen cell, and the n-1 partial pressure ratios are determined from equations involving ion beam intensities and cell temperatures. The ratio of constants of proportionality of ion beam intensity and partial pressure can be calculated, and from this the ratios for the ionization cross sections for the species can be determined if the relative response of the spectrometer to the different ion beams is determined.

STR.03:002

Stanford Research Inst., Menlo Park, Calif.

A CALCULATION OF THE ENERGIES OF GASEOUS ALKALI HALIDE DIMER MOLECULES, by T. A. Milne and D. Cubicciotti. May 1958, 15p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-58-475) (AF 49(638)89) AD 158286; PB 135405 Unclassified

Also published in Jour. Chem. Phys., v. 29: 846-851, Oct. 1958.

The energies of formation of gaseous alkali halide dimer molecules from the monomers have been calculated using a model suggested by Pauling. The dimers were found to be from 40 to 60 kcal more stable, energetically, than their separated monomers. These results are in agreement with the experimental data available. The free energies of dimerization were estimated and used to predict the trends observed in the ratio of monomer to dimer for several salts. It was found that the energies of dimers with different cations were slightly more negative than the average of the two pure dimers. Some experimental results supporting this conclusion are presented. (Contractor's abstract)

STR.03:003; STA.12:001-003; STA.13:001

STR.03:003

Stanford Research Inst., Menlo Park, Calif.

FURTHER CALCULATIONS OF GASEOUS ALKALI HALIDE SPECIES, by T. A. Milne and D. Cubicciotti. Feb. 1958 [9]p. incl. diagrs. tables. (Technical note no. 3) (AFOSR-TN-58-592) (AF 49(638)89) AD 162116
Unclassified

The application of the simple Pauling model to the calculation of the binding energies of the gaseous monomer and dimer alkali halide molecules has been extended to include the case of the trimer molecule. Consideration of the possible structures for a complete ionic trimer molecule has led to the decision that in the absence of directed bonds the six member planar ring will be the most stable. Thus the energies of such structures for the alkali halides were calculated with the Pauling model. The energy has been calculated by means of a numerical variational procedure. The energies of alkali halide M_2X^+ molecule ions were also calculated.

STA.12:001

Stanford U. Applied Mathematics and Statistics Lab., Calif.

ON CERTAIN NONLINEAR ELLIPTIC DIFFERENTIAL EQUATIONS AND UNIVALENT MAPPINGS, by E. Heinz. [1957] [76]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)294] and Office of Naval Research)
Unclassified

Published in Jour. Analyse Math. (Jerusalem), v. 5: 197-272, 1956/1957.

The principal object of this paper is a detailed study of certain second order systems of the following type:

$$\Delta x_m = Q_m \left(\frac{\partial x_1}{\partial u}, \dots, \frac{\partial x_n}{\partial u}; \frac{\partial x_1}{\partial v}, \dots, \frac{\partial x_n}{\partial v}; x_1, \dots, x_n; u, v \right)$$

($m = 1, \dots, n$), where the unknown functions $x_m(u, v)$ are assumed to be real and of class $C^{(2)}$ in a domain of the u - v -plane, and Q_m are quadratic polynomials in the

quantities $\frac{\partial x_1}{\partial u}, \dots, \frac{\partial x_n}{\partial v}$.

STA.13:002

Stanford U. Applied Mathematics and Statistics Lab., Calif.

ALMOST PERIODIC COMPACTIFICATIONS, by K.

de Leeuw and I. Glicksberg. Dec. 16, 1958, 12p. incl. refs. (Technical note no. 1) (AFOSR-TN-58-934) (AF 49(638)294) AD 205092
Unclassified

Also published in Bull. Amer. Math. Soc., v. 65: 134-139, May 1959.

Let B be a Banach space and S a uniformly bounded semigroup of operators on B . S is called almost periodic (a.p.) [weakly almost periodic (w.a.p.)] if each orbit is conditionally compact in the norm topology [weak operator topology] of B . In both cases, the closure \bar{S} of S in the algebra of bounded operators on B supplied with the weak operator topology is a compact semigroup. Some results are announced, without proofs, in which such a "compactification" plays a role. (Math. Rev. abstract)

STA.12:003

Stanford U. Applied Mathematics and Statistics Lab., Calif.

HOMOMORPHISMS OF CERTAIN ALGEBRAS OF MEASURES, by I. Glicksberg. Dec. 31, 1958, 25p. (Technical note no. 2) (AFOSR-TN-58-1042) (AF 49(638)294) AD 206572; PB 138743
Unclassified

Also published in Pacific Jour. Math., v. 10: 167-191, 1960.

Methods are discussed for determining all norm-decreasing homomorphisms of certain algebras of measures (similar to the Lie algebras) on G into the algebra of measures on H ; G and H are locally compact groups. Let $M(G)$ denote the Banach algebra of all finite, complex, regular Borel measures on G (with convolution as multiplication). $L_1(G)$ forms a subalgebra of $M(G)$, in fact an ideal. Because of this, knowledge of the norm-decreasing homomorphisms of L_1 algebras into algebras of measures on another group leads to the determination of all norm-decreasing isomorphisms between $M(G)$ and $M(H)$. When G and H are abelian, for each norm-decreasing isomorphism of a (not necessarily closed) subalgebra of $M(G)$ which contains $L_1(G)$ with a similar subalgebra of $M(H)$, there is an isomorphism γ of G onto H and a fixed character \hat{g} of G for which $T\mu$ is just the measure $\hat{g}\mu(\hat{g}u(dx) = \hat{g}(x)u(dx))$ transported to H via γ , where $TL_1(G) = L_1(H)$ and T is an isometry. In the noncommutative case, only the analogous result can be obtained for compact groups and T must be assumed to be an isometry.

STA.13:001

Stanford U. Dept. of Aeronautical Engineering, Calif.

A SURVEY OF THE THEORIES OF CREEP BUCKLING,

STA.13:002; STA.14:001, 002;
STA.15:001

by N. J. Hoff. June 1958, 80p. incl. diagrs. tables, refs. (SUDAER no. 80) (AFOSR-TN-58-733) (AF 49(838)223) AD 182268
Unclassified

Also published in Proc. Third U. S. Nat'l. Congress of Appl. Mech., Brown U., Providence, R. I. (June 11-14, 1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 29-49.

A survey is presented of the theories of buckling of structural elements whose material is subject to creep deformations. Two fundamentally different approaches to the solution of the buckling problem are discussed. In one, the structural element is assumed to be perfect and perfectly centered under the loads, and buckling is initiated by a disturbance in the configuration. In the second, the creep deformations begin in consequence of the deviation of the unloaded centerline or median plane of the structural element from the line of load application. In both cases the element has a finite lifetime. A critical time of creep buckling is defined beyond which the element cannot be used to carry the prescribed loads. (Contractor's abstract)

STA.13:002

Stanford U. Dept. of Aeronautical Engineering, Calif.

A THEORY OF ELASTIC, PLASTIC, AND CREEP DEFORMATIONS OF AN INITIALLY ISOTROPIC MATERIAL SHOWING ANISOTROPIC STRAIN-HARDENING, CREEP RECOVERY, AND SECONDARY CREEP, by J. F. Besseling. [1958] [8]p. incl. diagrs. refs. (AF 49(838)223) Unclassified

Published in Jour. Appl. Mech., v. 25: 529-536, Dec. 1958.

Stress-strain relations are given for an initially isotropic material, which is macroscopically homogeneous, but inhomogeneous on a microscopic scale. An element of volume is considered to be composed of various portions, which can be represented by subelements showing secondary creep and isotropic work hardening in plastic deformation. If the condition is imposed that all sub-elements of an element of volume are subjected to the same total strain, it is demonstrated that the inelastic stress-strain relations of the material show anisotropic strain-hardening, creep recovery, and primary and secondary creep due to the nonuniform energy dissipation in deformation of the subelements. Only quasi-static deformations under isothermal conditions are considered. The theory is restricted to small total strains. (Contractor's abstract)

STA.14:001

Stanford U. Dept. of Chemistry, Calif.

A MINIATURE GLASS HEAT EXCHANGER FOR MI-

CROSECOND RANGE, by J. D. Ray and T. Katan. [Oct. 1958] [7]p. incl. illus. (AFOSR-TN-58-858) (AF 49(838)-288) AD 235472
Unclassified

The heat exchanger described was the result of adaptation of construction methods used in a thermostable

1 cm i.d. sample probe for N¹⁴ magnetic resonance studies. The heat exchanger is intended for use in rapid trapping of free radicals in high concentration for magnetic resonance studies.

STA.14:002

Stanford U. Dept. of Chemistry, Calif.

TERTIARY BUTYL FORMATE: PREPARATION AND MAGNETIC RESONANCE SPECTRUM, by R. A. Ogg, Jr., C. Franconi, and J. D. Ray. [Oct. 1958] 4p. incl. diagrs. (AFOSR-TN-58-857) (AF 49(838)286) AD 203499
Unclassified

Tertiary butyl formate was found to have a nuclear magnetic resonance spin-spin coupling across five bonds between the methyl and formyl protons of 0.25 c at 30 mc. The reaction of 1 mole of t-butanol with 12.8 moles of formic acid to produce t-butyl formate and water was found to have approximately zero heat of reaction with equilibrium constant 0.21. An azeotrope of alcohol and ester was found to have a bp of 79.3°.

STA.15:001

Stanford U. Dept. of Mechanical Engineering, Calif.

SOME PRELIMINARY RESULTS OF VISUAL STUDIES ON THE FLOW MODEL OF THE WALL LAYERS OF THE TURBULENT BOUNDARY LAYER, by S. J. Kline and P. W. Runstadler. Apr. 1958 [17]p. incl. illus. diagrs. refs. (Rept. no. MD-3) (AFOSR-TN-58-160) (AF 49(838)295) AD 152187
Unclassified

Also published in Jour. Appl. Mech., v. 28: 160-170, June 1959.

Preliminary studies of the flow model in the wall layers of the turbulent boundary layer are presented. Results are summarized for investigations of positive pressure gradients, zero and negative pressure gradients, reattaching zones, and the later stages of transition. In all cases, the special visual methods developed for these studies show a definite three dimensional vortex flow model. The presently available details of this model are described, a possible interpretation of the physics of the turbulent boundary layer is given, and some of the many implications of the flow model are discussed. (Contractor's abstract)

STA.15:002-004; STA.03:037, 038

STA.15:002

Stanford U. Dept. of Mechanical Engineering, Calif.

ON THE NATURE OF STALL, by S. J. Kline. June 1958, 72p. incl. illus. diagrs. refs. (Rept. no. MD-4) (AFOSR-TN-58-637) (AF 49(638)201 and AF 49(638)295) AD 162168 Unclassified

Also published in Jour. Basic Engineering, v. 81: 305-320, Sept. 1959.

The physical data available on the problem of stall are reviewed. The discussion is centered on the problem of flow in passages, but a few comparisons with external flow are given. The emphasis is placed on systematic visual data showing flow patterns as a function of geometrical parameters. These data lead to a view of stall as a spectrum including three or possibly four major types of flow patterns; these patterns involve both transient and steady elements. A qualitative parameter is formulated which provides a classification for the major types of stall. A few experiments performed specifically to check the concepts inherent in this parameter are described. Results show that these concepts are useful in rationalizing known but previously inexplicable results and in obtaining important qualitative predictions. (Contractor's abstract)

STA.15:003

Stanford U. Dept. of Mechanical Engineering, Calif.

OPTIMUM DESIGN OF STRAIGHT-WALLED DIFFUSERS, by S. J. Kline, D. E. Abbott, and R. W. Fox. June 1958, 32p. incl. diagrs. table, refs. (Rept. no. PD-4) (AFOSR-TN-58-638) (AF 49(638)201 and AF 49(638)295) AD 162169 Unclassified

Also published in Jour. Basic Engineering, v. 81: 321-331, Sept. 1959.

Four common optimum problems in diffuser design are defined. These optima are located in relation to the overall flow regimes in terms of geometrical parameters for straight-walled units. Using an empirically derived transformation of variables between the conical and 2-dimensional geometries, all available data for optimum recovery at constant ratio of wall length to throat width are correlated by a single straight line. This line lies slightly above and parallel to the line of onset of large transitory stall on the chart of overall flow regimes. The correlated results are based on a literature survey. The range of conditions for each investigation is tabulated for convenient future reference. The emphasis is on design. Remarks concerning the possible extent and use of the correlations presented are included. (Contractor's abstract)

STA.15:004

Stanford U. Dept. of Mechanical Engineering, Calif.

INVESTIGATIONS OF THE FLOW MECHANISMS IN TURBULENT BOUNDARY LAYERS, AND DIFFUSING PASSAGES, AND OF STALL, by S. J. Kline. Final rept. Dec. 31, 1958, 7p. (AF 49(638)295) Unclassified

This final report gives a summary of progress under each of these following items: (1) flow models in the wall layers of the turbulent shear layer; (2) adverse pressure gradient channel flows; and (3) theoretical studies of governing parameters of wall layer instabilities.

STA.03:037

Stanford U. Dept. of Physics, Calif.

PAIR-CREATION CROSS SECTION OF SPIN ONE-HALF PARTICLES POSSESSING AN ANOMALOUS MAGNETIC MOMENT, by G. H. Rawitscher. Jan. 1957 [10]p. incl. diagrs. refs. (Technical rept. no. 21) (AFOSR-TN-57-27) (AF 18(600)545) AD 115062 Unclassified

Also published in Phys. Rev., v. 107: 274-276, July 1, 1957.

The electromagnetic pair-production cross section of spin-1/2 particles possessing an anomalous magnetic moment γ (in units of $ef/2mc$) is calculated. The result is compared with the experimental measurement of the pair production of μ mesons, and it is found that $-0.4 < \gamma < 0.2$. (Contractor's abstract)

STA.03:038

Stanford U. Dept. of Physics, Calif.

ELECTRON SCATTERING FROM ASPHERICAL NUCLEI, by B. W. Downs, D. G. Ravenhall, and D. R. Yennie. Feb. 1957 [18]p. incl. diagrs. (Technical rept. no. 22) (AFOSR-TN-57-36) (AF 18(600)545) AD 115074 Unclassified

Also published in Phys. Rev., v. 106: 1285-1289, June 15, 1957. (Title varies)

To explain the anomalously smooth cross sections observed in electron scattering from certain nuclei (Hf, Ta, W, U), the contributions to the cross section arising from the aspherical character of those nuclei have been examined. Approximations are developed for the calculation of these contributions, and for a sample case, Ta, numerical results are given; the value required for the nuclear distortion in order to obtain agreement with experiment in this case is in good agreement with the spectroscopic and Coulomb-excitation values. The results

STA.03:039 - STA.03:043

suggest that in certain cases electron scattering will be a useful new method for measuring both the magnitude and the radial shape of nuclear deformations.

STA.03:039

Stanford U. Dept. of Physics, Calif.

CENTER-OF-MASS MOTION IN MANY-PARTICLE SYSTEMS, by S. Gartenhaus and C. [L.] Schwartz. Apr. 1957 [38]p. incl. refs. (Technical rept. no. 23) (AFOSR-TN-57-184) (AF 18(600)545) AD 126479
Unclassified

Also published in Phys. Rev., v. 108: 482-490, Oct. 15, 1957.

An explicit construction is found for a unitary operator which insures the free motion of the center of mass of any many-particle wave function on which it is allowed to act. The transformation is used to calculate recoil correction terms for the internal energy and external interactions of nuclei, and some numerical evaluations are given for cases of interest. The many-body harmonic oscillator problem is exactly soluble using the transformation, and one is thus enabled to give a more general discussion of the spurious states. (Contractor's abstract)

STA.03:040

Stanford U. [Dept. of Physics] Calif.

PROTON POLARIZABILITY CORRECTION TO ELECTRON-PROTON SCATTERING, by S. D. Drell and M. A. Ruderman. [1957] [3]p. incl. diagrs. [AF 18(600)-545]
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 62-63, Jan. 30, 1957.

Also published in Phys. Rev., v. 106: 561-563, May 1, 1957.

The contribution to observed electron-proton scattering cross sections of the electron-induced polarization of the proton is estimated and found to be small for electron energies < 500 mev. (Contractor's abstract)

STA.03:041

Stanford U. [Dept. of Physics] Calif.

HARTREE-FOCK SOLUTION FOR THE HELIUM-4 NUCLEUS (Abstract), by C. L. Schwartz. [1957] [1]p. [AF 18(600)545]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 228, Apr. 25, 1957.

In a recent abstract Aviles and Jastrow have reported a Hartree-Fock calculation of the He^4 nucleus using a Yukawa two-body force. They find a binding energy of only 10 mev, compared with 55 mev obtained by Irving who used the same force but a more complicated wave function. The purpose of this note is to point out that a large part of this discrepancy lies in the simple kinematical correlation associated with the free motion of the center of mass. If the total translational invariance of the trial function is assured by the unitary transformation previously described, the Hartree-Fock equation is modified only in that the kinetic energy term is multiplied by 3/4. A variational calculation with a simple one-parameter analytic function then yields a binding energy of 44 mev; the exact Hartree-Fock solution should give even more binding. Thus, at most, 20% of the binding in Irving's calculation is due to dynamical correlations. The smallness of such correlations is a measure of the validity of the independent particle model.

STA.03:042

Stanford U. Dept. of Physics, Calif.

ELECTRON SCATTERING AND MODEL INDEPENDENCE, by D. G. Ravenhall and D. R. Yennie. [1957] [6]p. incl. diagrs. table, refs. [AF 18(600)545]
Unclassified

Published in Proc. Phys. Soc. (London), v. 70A: 857-862, Dec. 1, 1957.

A critical examination is made of the hypothesis of model independence in high-energy electron scattering from nuclei. Results are presented which indicate that, contrary to this hypothesis, any differences in nuclear charge distributions result in differences in the electron angular distributions which become more and more pronounced as the energy is increased. The fallacies of the arguments leading to this hypothesis are noted, and comments are made on the scattering process. (Contractor's abstract)

STA.03:043

Stanford U. Dept. of Physics, Calif.

QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES, by S. D. Drell. Jan. 1958, 25p. incl. diagrs. refs. (Technical rept. no. 24) (AFOSR-TN-58-46) (AF 18(600)545) AD 148086
Unclassified

Also published in Ann. Phys., v. 4: 75-86, May 1, 1958.

STA.03:044 - STA.03:047

The validity of quantum electrodynamics (QED) at small distances is discussed in the light of present experimental information. Large-angle pair production in hydrogen, together with elastic electron-proton scattering, is analyzed as a means of obtaining further information on the small distance behavior of QED. (Contractor's abstract)

STA.03:044

Stanford U. Dept. of Physics, Calif.

ELECTROMAGNETIC STRUCTURE OF THE NEUTRON, by L. I. Schiff. Feb. 1958 [15]p. incl. diagrs. refs. (Technical rept. no. 25) (AFOSR-TN-58-123) (AF 18(600)545) AD 152150 Unclassified

Also published in Rev. Modern Phys., v. 30: 462-464, Apr. 1958.

Recent experiments on elastic and inelastic electron-deuteron scattering, with their theoretical interpretations, are considered in the light of a possible non-vanishing electric charge distribution of the neutron. The most likely conclusion is that the neutron charge density is zero and the neutron anomalous magnetic moment density is like that of the proton. (Contractor's abstract)

STA.03:045

Stanford U. Dept. of Physics, Calif.

DETERMINANTAL APPROACH TO MESON-NUCLEON SCATTERING, by M. Baker. Feb. 1958 [57]p. incl. diagr. refs. (Technical rept. no. 26) (AFOSR-TN-58-136) (AF 18(600)545) AD 152163 Unclassified

Also published in Ann. Phys., v. 4: 271-305, July 1958.

A treatment of scattering is presented where the construction of the scattering phase-shifts is regarded as an energy-value problem. Using the relation between the phase-shift $\delta(E)$ and the energy-shift ΔE , the phases can be obtained directly from the infinite determinant $D(E) = \det \left(\frac{E-H}{E-H_0} \right) = \prod_k \left(\frac{E-E_k}{E-E_{0k}} \right) = \prod_k \left(1 - \frac{\Delta E_k}{E-E_{0k}} \right)$,

where the E_k are the energy eigenvalues of the interacting system and E_{0k} are the corresponding eigenvalues for the non-interacting system. For the problem of potential scattering this procedure is directly applicable and leads to results equivalent to the Fredholm solution of the scattering integral equation. However, for the interacting meson-nucleon system, $D(E)$ does not exist. In order to apply this method, $D(E)$ must be factored into convergent subdeterminants $O_i(E)$,

each of which refer to a particular class of states. From $D_1(E)$, the subdeterminant referring to a one-meson type state, the scattering phase-shifts can be calculated. A procedure for constructing $D_1(E)$ for the meson-nucleon system is developed by using the formal structure of $D(E)$. This method is then applied to calculate meson-nucleon scattering in the static model. The $D_1(E)$ is expanded in a power series, such that the first two terms of the expansion yield a solution for the phase-shifts similar to results given by the Chew-Low one-meson approximation. (Contractor's abstract, modified)

STA.03:046

Stanford U. Dept. of Physics, Calif.

CONVERGENCE OF THE S-MATRIX, by D. R. Yennie and S. Gartenhaus. Feb. 1958, 29p. (Technical rept. no. 27) (AFOSR-TN-58-137) (AF 18(600)545) AD 152164 Unclassified

Also published in Nuovo Cimento, Series X, v. 9: 59-76, July 1, 1958.

An investigation is made of the convergence of the field-theoretic perturbation expansion of the elements of the S-matrix. A theory characterized by a coupling linear in the boson field is assumed, and a cutoff is introduced in momentum space. It is established that the transition amplitude for any given process over a finite time interval is bounded term by term by an exponential series. There is an extension of the method to interactions which are not linear in the boson field. The implications of the results for theories without a cutoff are discussed from a qualitative point of view. (Contractor's abstract, modified)

STA.03:047

Stanford U. Dept. of Physics, Calif.

DECAY OF K-MESONS AS A TEST OF THE UNIVERSAL FERMI INTERACTION, by F. Zachariasen. Mar. 1958 [9]p. incl. diagrs. (Technical rept. no. 28) (AFOSR-TN-58-187) (AF 18(600)545) AD 152221 Unclassified

Also published in Phys. Rev., v. 110: 1481-1482, June 15, 1958.

Decays in which electron and μ -meson coupling may be compared are reviewed as background for the K_{e3} and $K_{\mu3}$ decays of K^+ mesons which show both the electron and the μ -meson decay mode. The process of the K_{e3} and $K_{\mu3}$ decays is suggested as a means of testing the universal interaction hypothesis, and a discussion is given of the experimental information needed for such a test. (ASTIA abstract)

STA.03:048 - STA.03:052

STA.03:048

Stanford U. Dept. of Physics, Calif.

IMPROVED SUM RULE FOR ELECTRON-DEUTERON SCATTERING, by R. Blankenbecler. May 1958, 28p. incl. table, refs. (Technical rept. no. 29) (AFOSR-TN-58-410) (AF 18(600)545) AD 158213; PB 134762
Unclassified

Also published in Phys. Rev., v. 111: 1684-1690, Sept. 15, 1958.

A qualitative discussion of the approximations implicit in the present theoretical treatment of the deuteron is presented. An improved sum rule which relates the total elastic and inelastic scattering of electrons from the deuteron to the free electron-nucleon cross sections is derived. It has the property of reducing to the correct relativistic result upon neglect of binding. It is proved that the use of folded nucleon and nuclear form factors is correct. It is shown that the finite-nucleon size does not affect any real photon process. (Contractor's abstract)

STA.03:049

Stanford U. Dept. of Physics, Calif.

FORM FACTORS IN QUANTUM ELECTRODYNAMICS, by S. D. Drell and F. Zachariasen. June 1958, 37p. incl. diagrs. refs. (Technical rept. no. 31) (AFOSR-TN-58-411) (AF 18(600)545) AD 158214
Unclassified

Also published in Phys. Rev., v. 111: 1727-1735, Sept. 15, 1958.

The electromagnetic form factors of an electron in pure quantum electrodynamics (QED) are analyzed with the techniques of dispersion relations. The viewpoint is adopted that no subtractions are required in the construction of dispersion relations for the electromagnetic vertex. This leads to coupled integral equations for the form factors in terms of other physical amplitudes, e.g., electron-positron scattering. The relation between this and the usual perturbation approach to QED, and the validity and consequences of the "no subtraction" philosophy, are discussed. (Contractor's abstract)

STA.03:050

Stanford U. Dept. of Physics, Calif.

PC CONSERVATION IN STRONG INTERACTIONS, by S. D. Drell, S. C. Frautschi, and A. M. Lockett, III. May 1958, 7p. incl. refs. (Technical rept. no. 30) (in cooperation with Los Alamos Scientific Lab., N. Mex.) (AFOSR-TN-58-412) (AF 18(600)545) AD 158215
Unclassified

The combined PC symmetry operation has been suggested as valid both for weak and strong interactions. In the case of weak interactions PC conservation has been used as a tenable selection rule. Strong interactions are generally believed to have both P and C individually as symmetry operations. S. N. Gupta has pointed out: (1) that PC invariance plus gauge invariance insures both P and C invariance in electrodynamics, and (2) that PC invariance alone leads to parity conservation in neutral pseudoscalar-meson theory. The PC invariance parity conservation question has now been extended to include the charged mesons, hyperons, and K mesons. Consideration is given to experimental complications in the application of the PC selection rule to the strong interactions. It is observed that the combined PC invariance plus charge independence imply separate P and C invariance for the direct coupling of pseudoscalar-mesons with nucleons.

STA.03:051

Stanford U. Dept. of Physics, Calif.

SUM RULES FOR INELASTIC ELECTRON SCATTERING, by S. D. Drell and C. L. Schwartz. June 1958 [40]p. incl. diagrs. refs. (Technical rept. no. 32) (AFOSR-TN-58-476) (AF 18(600)545) AD 158287
Unclassified

Also published in Phys. Rev., v. 112: 568-579, Oct. 15, 1958.

Sum rules are constructed for the analysis of inelastic electron scattering at high energy (~150 mev) from light nuclei. Effects taken into account are: (1) nucleon charge, recoil, and magnetic-moment currents; (2) exchange currents; (3) finite nucleon size; (4) nuclear center-of-mass motion; and (5) the kinematical factors describing the correct relation between initial and final electron energies. It appears that a sensitive test of the role of exchange currents in the nuclear ground state is provided by a sum rule for the energy-weighted cross section for fixed-momentum transfer q = constant $\sigma_E = \int \sigma(\epsilon, q) d\epsilon$. (Contractor's abstract)

STA.03:052

Stanford U. Dept. of Physics, Calif.

ELECTRON-DEUTERON SCATTERING BY THE IMPULSE APPROXIMATION, by A. Goldberg. June 1958 [17]p. incl. diagrs. (Technical rept. no. 35) (AFOSR-TN-58-536) (AF 18(600)545) AD 158352
Unclassified

Also published in Phys. Rev., v. 112: 618-622, Oct. 15, 1958.

The cross section of inelastic scattering of high-energy electrons by deuterons is calculated using the impulse approximation. The results agree with those of Jankus.

STA.03:053 - STA.03:056

The cross sections are given for several neutron charge and moment distributions. The peak cross sections are simply related to the free-nucleon cross sections with this approximation. (Contractor's abstract)

STA.03:053

Stanford U. Dept. of Physics, Calif.

WIDE-ANGLE PAIR PRODUCTION AND QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES, by J. D. Bjorken, S. D. Drell, and S. C. Frautschi. July 1958, 32p. incl. diagrs. table, refs. (Technical rept. no. 34) (AFOSR-TN-58-597) (AF 18(600)545) AD 162121 Unclassified

Also published in Phys. Rev., v. 112: 1409-1417, Nov. 15, 1958.

Wide angle photoproduction of high-energy electron-positron pairs in hydrogen is proposed and analyzed as a test of quantum electrodynamics at distances $\leq 10^{-13}$ cm. The effect of proton structure can be removed in terms of the two form factors measured in the elastic electron-proton scattering process. Cross sections are presented for pair production experiments in which: (1) one of the final particles is detected, and (2) coincidence is detected. In addition to kinematic, anomalous moment, and nucleon form-factor corrections to the Bethe-Heitler formula, dynamical corrections to the proton current and radiative corrections are calculated. The final theoretical formula is believed to be accurate to within 2 percent. A simple cutoff model suggests that 5 percent accuracy in a particle detection experiment tests the electron propagator at distances $\sim 0.7 \times 10^{-13}$ cm, while a 10 percent accuracy in a coincidence experiment probes the electron propagator at $\sim 0.3 \times 10^{-13}$ cm. (Contractor's abstract, modified)

STA.03:054

Stanford U. Dept. of Physics, Calif.

NEW TECHNIQUES IN THE LAMB SHIFT CALCULATIONS, by H. M. Fried and D. R. Yennie. July 1958, 42p. incl. diagrs. table, refs. (Technical rept. no. 36) (AFOSR-TN-58-678) (AF 18(600)545) AD 162210 Unclassified

Also published in Phys. Rev., v. 112: 1391-1404, Nov. 15, 1958.

Based on the analogy between the calculations of radiative corrections to electron scattering and the Lamb shift, a new procedure applicable to bound state self-energy problems is developed, wherein the electron propagator is expanded in powers of the external potential. In the resulting sequence, a change in the gauge of the virtual photon field conveniently removes from

each term spurious lower order contributions and yields a new and considerably simpler sequence. The expectation value of the first two terms of the latter is shown to account for the major portion of the Bethe logarithm. A simple method is developed to sum all the $\alpha(Z\alpha)^4 \mu$ dependence, and the result is the lowest order Lamb shift formula. The straightforwardness in the above calculation, as well as in the calculation of the relativistic level shift correction of order $\alpha(Z\alpha)^5 \mu$ (not given in the present paper) indicates that the method may find application in the calculation of further higher order effects. (Contractor's abstract, modified)

STA.03:055

Stanford U. Dept. of Physics, Calif.

SIGN OF THE GRAVITATIONAL MASS OF A POSITRON, by L. I. Schiff. Sept. 1958 [4]p. (Technical rept. no. 42) (AFOSR-TN-58-783) (AF 18(600)545) AD 202008 Unclassified

Also published in Phys. Rev. Letters, v. 1:254-255, Oct. 1, 1958.

It is suggested that an antiparticle may have the opposite sign of gravitational mass from its corresponding particles. Work is presented to point out that this sign can be determined experimentally in the case of a positron. In these experiments the ratio of gravitational to inertial mass was measured for several substances. An attempt was made to detect differences in this ratio between one substance and another but no definite evidence for such differences was found. In several cases, the uncertainties in the fractional differences of the ratios were less than one part in 10^8 . (Contractor's abstract, modified)

STA.03:056

Stanford U. Dept. of Physics, Calif.

NUCLEON FORM FACTORS FROM ELECTROPRODUCTION OF PIONS, by S. Gartenhaus and C. N. Lindner. Sept. 1958 [18]p. incl. diagrs. refs. (Technical rept. no. 37) (AFOSR-TN-58-819) (AF 18(600)545) AD 202351 Unclassified

Also published in Phys. Rev., v. 113: 917-920, Feb. 1, 1959.

The dispersion relation analysis of Fubini, Nambu, and Wataghin (Phys. Rev., v. 111: 329, 1958) for electro-pion production was applied to the experiments of Panofsky and Allton (Phys. Rev., v. 110: 1155, 1958) as an independent means for studying nucleon structure. The results are in qualitative agreement with those from

STA.03:057 - STA.03:061

elastic scattering experiments. Some of the limitations inherent in the form factor measurements by this process are also discussed. (Contractor's abstract)

STA.03:057

Stanford U. Dept. of Physics, Calif.

HIGH-ENERGY BREMSSTRAHLUNG IN ELECTRON-PROTON COLLISIONS, by R. A. Berg and C. N. Lindner. Sept. 1958 [20]p. incl. diagrs. refs. (Technical rept. no. 38) (AFOSR-TN-58-830) (AF 18(600)-545) AD 202915 Unclassified

Also published in Phys. Rev., v. 112: 2072-2076, Dec. 15, 1958.

The cross section for the bremsstrahlung resulting from high-energy collisions of electrons with protons is calculated, considering the electrons as extremely relativistic and taking into consideration the proton's recoil, anomalous magnetic moment, bremsstrahlung and form factors. The final cross section is integrated over the recoil proton and final photon to obtain a formula of interest for the Stanford accelerator experiments. The computation of the integrated cross section made without regard for radiative corrections and mesonic contributions is estimated to be accurate to 2% in the energy ranges of interest. This cross section is corrected for radiative effects, which produce an additional uncertainty of less than 5% and possibly as little as 1%. Resonance effects due to meson interactions in the virtual Compton effect diagrams, however, are significant in the range of interest. Their contribution to the cross section is discussed. (Contractor's abstract)

STA.03:058

Stanford U. Dept. of Physics, Calif.

CALCULATIONS IN SCHRÖDINGER PERTURBATION THEORY, by C. [L.] Schwartz. Sept. 1958, 24p. Incl. table, refs. (Technical rept. no. 39) (AFOSR-TN-58-831) (AF 18(600)545) AD 202916 Unclassified

Also published in Ann. Phys., v. 6: 156-169, Feb. 1959.

The evaluation of second- and higher-order perturbations of the energy by iterative solution of Schrödinger's equation, rather than by evaluation of the well-known matrix formulas, is described and exploited. Several examples are worked out exactly for the hydrogen atom, to point the way for other more practical, but more involved, problems. (Contractor's abstract)

STA.03:059

Stanford U. Dept. of Physics, Calif.

ON THE USES OF APPROXIMATE WAVE FUNCTIONS, by C. [L.] Schwartz. Sept. 1958 [14]p. incl. tables. (Technical rept. no. 40) (AFOSR-TN-58-832) (AF 18(600)545) AD 202917 Unclassified

Also published in Ann. Phys., v. 6: 170-177, Feb. 1959.

A procedure is given for using approximate wave functions to calculate properties of a system other than the energy to an accuracy much greater than that previously thought to be possible. The method is based on the form of perturbation theory, but stands by itself as an independent and very powerful innovation. Several sample problems, based on the two-electron atom, are worked out; and a program of greatly increasing the accuracy in the calculation of many properties of atomic systems is envisaged. (Contractor's abstract, modified)

STA.03:060

Stanford U. Dept. of Physics, Calif.

A NEW CALCULATION OF THE NUMERICAL VALUE OF THE LAMB SHIFT, by C. [L.] Schwartz and J. J. Tiemann. Sept. 1958, 16p. incl. table (Technical rept. no. 41) (AFOSR-TN-58-833) (AF 18(600)545) AD 202918 Unclassified

Also published in Ann. Phys., v. 6: 178-187, Feb. 1959.

The calculation of the second-order perturbation in hydrogen which gives the low-energy part of the Lamb shift is attacked from a new extended approach. A formula is derived for $\ln(k_0)$ involving a double integral.

The final numerical evaluation using an electronic computer to sum the series expansion of this formula yields what appears to be the most accurate value of $\ln(k_0)$ yet given. Small discrepancies with the earlier results of Flannery are outside the realm of current physical significance. However, these discrepancies indicate the reliability of the earlier results to be badly overestimated. Approximate formulas for the radiative-perturbed wave functions are given, and may prove quite useful for further calculations. (Contractor's abstract)

STA.03:061

Stanford U. Dept. of Physics, Calif.

NUCLEON CORRELATION EFFECTS IN HIGH-ENERGY ELECTRON SCATTERING, by W. E. Drummond. June 1958 [36]p. incl. diagrs. refs. (Technical rept. no. 33) (AFOSR-TN-58-1003) (AF 18(600)545) AD 206046 Unclassified

STA.03:062-064; STA.16:001

Also published in Phys. Rev., v. 116: 183-193, Oct. 1959.

Using Schiff's high-energy approximation a sum rule is developed which relates the scattering of high-energy electrons from heavy nuclei to the two-particle correlation function for the nucleus. It is shown that correlations due to the Pauli principle give a large effect in the region of momentum transfer from 100 to 300 mev/c, and that correlations with a range of less than one fermi do not make an appreciable contribution. (Contractor's abstract)

STA.03:062

Stanford U. Dept. of Physics, Calif.

ASYMPTOTIC EXPANSION FOR HIGH-ENERGY POTENTIAL SCATTERING, by J. J. Tienann. [1958] [6]p. incl. diags. (AF 18(600)545) Unclassified

Published in Phys. Rev., v. 109: 183-188, Jan. 15, 1958.

An asymptotic expansion of a previously derived approximate expression for high-energy potential scattering is obtained. This is used to compute numerical values for the large-angle differential scattering cross section of a Schrödinger particle scattered by a spherically symmetric parabolic potential well and of a relativistic electron scattered by a uniformly charged sphere. In both cases the parameters are such that the Born approximation cannot be used. These values are compared with the results of an exact partial wave calculation and (in the parabolic-well case) with the results of numerical integration of the full approximate expression, and of its asymptotic expansion. It is found that for both the Schrödinger equation and the Dirac equation the locations of the maxima and the minima of the scattering cross sections are reproduced with good accuracy. The magnitudes of the minima, however, are not given reliably and although the general shapes of the curves are correct, the magnitudes of the maxima differ from the correct values by 10 to 50%, depending on the value of kR . (Contractor's abstract)

STA.03:063

Stanford U. [Dept. of Physics] Calif.

SCATTERING OF K^+ MESONS IN EMULSIONS, by G. Igo, D. G. Ravenhall and others. [1958] [8]p. incl. diags. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)545] and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 109: 2133-2140, Mar. 15, 1958.

Some new experimental results on the scattering of K^+

mesons in emulsion are presented, in two energy ranges. $T_k = 40$ to 100 mev and $T_k = 150 \pm 30$ mev. An optical-model analysis is made of these results, which avoids many of the approximations of previous workers. It is concluded that the K^+ -nucleus interaction is repulsive and that the K^+ -nucleon cross section inside the nucleus is compatible with the observed cross section for free protons. (Contractor's abstract)

STA.03:064

Stanford U. [Dept. of Physics] Calif.

RADIATIVE CORRECTIONS TO THE HYPERFINE STRUCTURE IN THE 1S AND 2S STATES OF HYDROGEN (Abstract), by C. [L.] Schwartz. [1958] [1]p. [AF 18-(600)545] Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 404, Dec. 29, 1958.

Mittleman has recently given an account, according to the relativistic quantum electrodynamics, of the ratio of the hyperfine-structure separations in the 1S and 2S states of hydrogen. His result, proportional to α^3 , appears to be in disagreement with the experimental value. Working in analogy with Bethe's first description of the Lamb shift in hydrogen, the non-relativistic third-order perturbation theory has been set up to describe the effect: emission and reabsorption of a transverse photon by a bound electron while interacting with the field of the nuclear magnetic moment. Divergences in this calculation are eliminated by keeping only the state-independent terms, and then cutting off the intermediate photons at $\hbar\omega = mc^2$. Comparing, where possible, with Mittleman's results, it is found that he lacks a term both in the nonrelativistic sum over states and in the $\ln\alpha$ terms. While the numerical value of this nonrelativistic calculation should not be compared with the experimental value until the entire calculation is redone relativistically, our correction for the leading $\ln\alpha$ term indicates a closer agreement between theory and experiment.

STA.16:001

Stanford U. Dept. of Physics, Calif.

ANALYSIS OF THE ESR ABSORPTION SPECTRUM OF WURSTER'S BLUE ION, by T. R. Tuttle, Jr. [1958] [1]p. incl. diags. (Technical note no. 1) (AFOSR-TN-58-859) (AF 18(603)131) AD 230273 Unclassified

Also published in Jour. Chem. Phys., v. 30: 331, Jan. 1959.

STA.17:001; STA.04:002-004

The electron spin resonance spectrum of regular and deuterated forms of Wurster's blue ion shows that the triplet structure of the main lines is associated with the four ring protons. Spin densities at the methyl and ring protons have been calculated to be 0.0148 and 0.0042, respectively.

STA.17:001

Stanford U. Dept. of Physics, Calif.

GRAVITATIONAL PROPERTIES OF ANTIMATTER, by L. I. Schiff. Dec. 1958 [21]p. incl. diagrs. table, refs. (Technical note no. 1) (AFOSR-TN-58-1062) (AF 49(638)388) AD 207222 Unclassified

Also published in Proc. Nat'l. Acad. Sciences, v. 45: 69-80, Jan. 1959.

Arguments are given for believing that all particles and antiparticles have positive inertial and passive gravitational masses, and that the principle of equivalence is valid to a high accuracy. Speculations are made about the active gravitational masses of antiparticles.

STA.04:002

Stanford U. Div. of Engineering Mechanics, Calif.

THE SOLUTION OF COMPRESSIBLE LAMINAR BOUNDARY LAYER PROBLEMS BY A FINITE DIFFERENCE METHOD. PART II. FURTHER DISCUSSION OF THE METHOD AND COMPUTATION OF EXAMPLES, by D. C. Baxter and I. Flügge-Lotz. Oct. 15, 1957, 220p. incl. diagrs. tables, refs. (Technical rept. no. 110) (AFOSR-TN-58-1) (AF 18(600)1488) AD 148040 Unclassified

The application of a finite difference solution of the corresponding differential equations to the investigation of the compressible boundary layer with variable pressure gradient and wall temperature is discussed. The Crocco form of the equations is used, and the method is programmed on an IBM 650 digital computer. For the purposes of the examples, the Prandtl number is assumed constant at 0.72, and the Sutherland viscosity law is used. With the exception of flows which involve overshoot, the method will allow determination of boundary-layer behavior under any combination of pressure gradient and wall temperature or heat flux variation. It is limited only in that (a) starting profiles must be provided at some distance downstream of the nose and (b) the time required to compute a particular example of interest may be long. The stability of the numerical solution of the boundary layer equations is investigated and consideration given to several examples involving flow over nonisothermal flat plates where the pressure gradient is zero. The heat transfer results are compared with the specializations and extensions of Lighthill's results.

STA.04:003

Stanford U. Div. of Engineering Mechanics, Calif.

THE SOLUTION OF COMPRESSIBLE LAMINAR BOUNDARY LAYER PROBLEMS BY A FINITE DIFFERENCE METHOD. PART III. THE INFLUENCE OF SUC-TION OR BLOWING AT THE WALL, by I. Flügge-Lotz and J. T. Howe. Oct. 15, 1957, 44p. incl. diagrs. tables. (Technical rept. no. 111) (AFOSR-TN-58-2) (AF 18-(600)1488) AD 148041 Unclassified

The influence of a transverse velocity at a porous wall on skin friction, heat transfer, and laminar separation is treated on a finite difference basis. The finite difference-scheme employed in the solution of the boundary layer problem (item nos. STA.04:001-002) is modified to include the transverse velocity effects in the computation at the wall point. Series expansions involving the shear stress and the enthalpy derivative are employed at each wall point. Skin friction and heat transfer parameters can be influenced appreciably by a small transverse velocity at the wall. A number of examples are presented to illustrate the effects of the transverse velocity in subsonic and supersonic flow over both hot and cold walls; examples with and without pressure gradient are discussed. In the absence of pressure gradient it appears that both skin friction and heat transfer parameters decrease with increasing transverse velocity parameter and vice versa. In boundary layer flows with a pressure gradient, the wall point shear stress equation is of the third degree in terms of the wall shear stress, but is quadratic in terms of the transverse velocity at the wall. The transverse velocity necessary to obtain a specified behavior of the wall shear stress, or a desired shift of the point of laminar separation can be computed readily. (ASTIA abstract)

STA.04:004

Stanford U. [Div. of Engineering Mechanics] Calif.

COMPRESSIBLE LAMINAR BOUNDARY LAYER BEHAVIOR STUDIED BY A FINITE DIFFERENCE METHOD, by D. C. Baxter and I. Flügge-Lotz. [1958] [16]p. incl. diagrs. refs. (AF 18(600)1488) Unclassified

Published in Zeitschr. Angew. Math. Phys., v. 9B: 81-96, Mar. 25, 1958.

The examples in this report show that in general the effects of pressure gradient are intensified at higher wall temperatures and higher Mach numbers. Raising the surface temperature has the effect of reducing skin friction, while lowering it tends to increase skin friction. However, surface temperature has much less effect on skin friction than it has on heat transfer. On the other hand pressure gradient does have an appreciable effect on heat transfer, although not as great as on skin friction. For flow over non-isothermal flat plates the

STA.07:025 - STA.07:027

specializations and extensions of Lighthill's result give very good agreement with the finite difference results for heat transfer. It follows that equally good agreement would be obtained with integral methods which assume unequal thicknesses for the velocity and thermal boundary layers. However, it is shown by the present examples that integral methods which make the assumption of equal thicknesses lead to inaccurate predictions of heat transfer performance when the wall temperature gradients are as high as those considered here (on the order of hundreds of degrees per foot). It appears that integral methods will give not unreasonable estimates for the skin friction even when that quantity is changing rapidly. This is not true of the correlation method, since the changes occurring in the present examples are too rapid to be related by the equilibrium conditions such a method assumes.

STA.07:025

Stanford U. High-Energy Physics Lab., Calif.

ELECTRON SCATTERING FROM THE DEUTERON AND THE NEUTRON-PROTON POTENTIAL, by J. A. McIntyre and S. Dhar. Feb. 28, 1957 [9]p. incl. diagrs. tables, refs. (Rept. no. HEPL-112) (AFOSR-TN-57-112) (Sponsored jointly by Office of Naval Research under N6onr-25116, Air Force Office of Scientific Research under AF 18(600)646, and Atomic Energy Commission) AD 120465 Unclassified

Also published in Phys. Rev., v. 106: 1074-1082, June 1, 1957.

Electron scattering from the deuteron has been investigated experimentally at higher energies and larger scattering angles than before. Calculations have been made also for the scattering expected from deuterons with repulsive-core and with Yukawa-type neutron-proton potentials. As before, it is found necessary to introduce a proton size into the deuteron (or to modify the Coulomb interaction) in order to obtain agreement between the experimental results and the scattering calculations. Using the proton size determined by electron-proton scattering experiments, a comparison is made between the various calculated curves and the experimental data. It is found to be impossible to rule out either the repulsive-core or the Yukawa potentials. (Contractor's abstract)

STA.07:026

Stanford U. High-Energy Physics Lab., Calif.

RESEARCH ON ELECTRON SCATTERING AND NUCLEAR STRUCTURE, by R. Hofstadter. Final rept. [1957] iv. incl. illus. diagrs. refs. (Rept. no. HEPL-122) (AFOSR-TR-57-34) (Sponsored jointly by Office

of Naval Research under [N6onr-25116], Air Force Office of Scientific Research under AF 18(600)646, and Atomic Energy Commission) AD 126543 Unclassified

Consideration is given to the study of the inner features of nucleons and nuclei by the method of electron scattering. Results are presented which appear significant from the point of view of a present understanding of the structure of nucleons and the nature of the basic nuclear force. A finite proton size was observed, the core of which is larger than that indicated by field theory. The magnetic cloud in the neutron was probed. The neutron's size was within $\pm 15\%$ of that of the proton. The broad basis on which nuclei are built was determined. The rules are that (1) the skin thickness (90% to 10% distance) of the electric charge distribution is $2.4 \pm 0.3 \times 10^{-13}$ cm for nuclei between Mg and Pb; and (2) the distance to the half-density point scales is $1.07 \times 10^{-13} A^{1/3}$ cm. Inelastic electron scattering from excited levels provided a new method for investigating the excited states in nuclei.

STA.07:027

Stanford U. [High-Energy Physics Lab.] Calif.

ELECTRON SCATTERING AND NUCLEAR STRUCTURE, by R. Hofstadter. [1956] [41]p. incl. illus. diagrs. tables, refs. [AFOSR-TR-57-34a] (Bound with its Final rept. AFOSR-TR-57-34, AD 126543) (Sponsored jointly by Office of Naval Research under [N6onr-25116], Air Force Office of Scientific Research under AF 18(600)646, and Atomic Energy Commission) AD 126543a Unclassified

Also published in Rev. Modern Phys., v. 28: 214-254, July 1956.

The influence of finite nuclear size on scattering formulae is described, and form-factors for the various models are derived. Phase-shift analysis for the heavy elements is discussed. The various scattering phenomena are explained, including nuclear excitation, electrodisintegration, the real and virtual radiative processes, magnetic scattering and effects due to "rotational levels". The spectrometer installations at the 190 mev and 550 mev points on the Stanford electron linear accelerator are described in detail, and a detailed review of the experimental work carried out at Stanford is given, in order of increasing target atomic number, viz. H, D, α , Li, Be, C, Mg, Si, S, A, Sr, heavier nuclei, and the neutron. The results include data on angular distribution, observed form-factors, cross-sections, etc. Comparisons are made with theory and conclusions drawn regarding the validity of the various models. For example, the data for protons indicate that the Gaussian, exponential and hollow-exponential models provide an equally good fit with experiment giving a mean proton radius for best fit of 0.77 ± 0.10 Fermi units. The Yukawa model does not satisfy the proton data. Finally, the validity of

STA.07:028 - STA.07:030

electrodynamics is discussed, and other methods of investigating nuclear structure are compared. It is concluded that the electron scattering method is promising, but still in an early stage of development. Future improvements are suggested.

STA.07:028

Stanford U. [High-Energy Physics Lab.] Calif.

NEUTRON-PROTON POTENTIAL AS DETERMINED BY ELECTRON SCATTERING FROM THE DEUTERON (Abstract), by J. A. McIntyre and S. Dhar. [1957] [1]p. (Sponsored jointly by Office of Naval Research under [N6onr-25116], Air Force Office of Scientific Research under AF 18(600)646], and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 14, Jan. 30, 1957.

Electrons with energies of 400 and 500 mev have been scattered from the deuteron. The scattering at the largest angles is a factor of five below that expected from scattering by a deuteron charge distribution. This discrepancy is removed by assuming that the proton in the deuteron has an rms radius of 0.78×10^{-13} cm. There is still some uncertainty in the expected deuteron scattering because of the various possible neutron-proton potentials in the deuteron. The scattering from three types of deuteron has been calculated using deuteron S- and D-state wave functions and the magnetic moment of the deuteron. One deuteron calculated has a repulsive core neutron-proton potential while the other two deuterons have Yukawa potentials. Comparison with the experimental data shows that agreement can be obtained for all deuteron models because of the uncertainty in the radius of the proton.

STA.07:029

Stanford U. [High-Energy Physics Lab.] Calif.

LARGE-ANGLE PAIR PRODUCTION AND QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES (Abstract), by J. D. Bjorken, S. D. Drell, and S. C. Frautschi. [1957] [1]p. [AF 18(600)646] Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 392, Dec. 19, 1957.

Electromagnetic pair production in hydrogen with large

momentum transfer provides a test of the validity of quantum electrodynamics (QED) at distances $\leq 10^{-13}$ cm. Because of center-of-mass motion electron-electron (positron) scattering at present energies ($E_{\text{lab}} \approx 1$ bev) is insensitive to distances $< 10^{-12}$ cm, as are radiative corrections, such as the electron's anomalous magnetic moment. The electron-proton scattering experiments of Hofstadter show that QED is valid down to $\sim 10^{-13}$ cm at which distances effects of nucleon structure appear.

Assuming the validity of QED for distances $\leq 10^{-13}$ cm, one can completely summarize the results of the electron-proton scattering experiments in two invariant functions of the four-momentum transfer, the proton's charge and moment form factors. The cross section for electromagnetic pair production in hydrogen is then known in terms of these two form factors, and the proton can be used, with known electromagnetic interactions, to fix the center-of-mass relative to the laboratory system. A complete calculation has been carried out, including radiative corrections, of large-angle pair production for photons incident on "Hofstadter" protons.

STA.07:030

Stanford U. [High-Energy Physics Lab.] Calif.

NUCLEON CHARGE AND MOMENT DISTRIBUTIONS (Abstract), by L. I. Schiff. [1957] [1]p. [AF 18(600)646] Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 389-390, Dec. 19, 1957.

The apparent failure of charge symmetry in the structure of the proton and the neutron is examined in the light of the possibility that the neutron charge density has zero volume integral and zero mean-square radius, but is not identically zero. Such a distribution must have at least two zeros as a function of radius. A simple analytic form is assumed that has a positive maximum at the origin, followed by a negative region and then a very small positive region. The proton charge density is then chosen so that when it is added to the neutron density, only the central positive maximum (the nucleon core distribution) remains. Proton and neutron magnetic moment densities are assumed to have the same form, and it makes little difference whether these have the simple shape used in earlier studies or the shape assumed here for the proton charge, which has one change of sign. It is then possible to fit the electron-proton and electron-deuteron elastic scattering data. The total electron-deuteron inelastic (break-up) scattering cross section is computed to be about 25 percent less than found experimentally. While these distributions can be regarded as meeting the requirements of charge

STA.07:031, 032; STA.08:002, 003

symmetry, they lead to a core distribution that has the same root-mean-square radius as that of the proton charge, although it has a more concentrated appearance.

STA.07:031

Stanford U. [High-Energy Physics Lab.] Calif.

SUM RULES FOR INELASTIC ELECTRON SCATTERING (Abstract), by S. D. Drell and C. L. Schwartz. [1957] [1]p. [AF 18(600)646] Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 390-391, Dec. 19, 1957.

Sum rules are constructed for the analysis of inelastic electron scattering at high energy (~150 mev) from light nuclei. Effects taken into account are: nucleon charge, recoil, and magnetic-moment currents; exchange currents; finite nucleon size; and nuclear center-of-mass motion. The form of the sum rule for fixed electron-scattering angle is complicated because of the kinematical connection between the momentum of the scattered electron and the energy of the final nuclear state. A more natural sum rule results for electron scattering with fixed momentum transfer. The energy region below meson threshold to which these considerations are restricted for reasons of ignorance of a relativistic nuclear description, precludes the possibility of learning about internucleon correlations (beyond the Pauli principle) from this work. However, it appears that a sensitive test of the role of exchange currents in the nucleus is provided by a sum rule for the energy-weighted cross section

$$\sigma_E = \int |q| = \text{const} \int \sigma(\epsilon, q) d\epsilon.$$

STA.07:032

Stanford U. High-Energy Physics Lab., Calif.

ELECTRON SCATTERING FROM THE DEUTERON AND THE NEUTRON-PROTON POTENTIAL, by J. A. McIntyre and G. R. Burleson. [1958] [10]p. incl. diagrs. tables, refs. (Sponsored jointly by Office of Naval Research under [N6onr-25116], Air Force Office of Scientific Research under [AF 18(600)646], and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 112: 2077-2086, Dec. 15, 1958.

Electron scattering by the deuteron has been studied experimentally at 400 and 500 mev. The results of the scattering are compared with the scattering expected by three different static deuteron models. All three models satisfy the usual deuteron requirements such as

binding energy, effective range, quadrupole moment, and percent D state. Two of the models have Yukawa neutron-proton potentials; the third has a repulsive-core potential. The experimental results agree with the repulsive-core model and disagree with the Yukawa models. This result applies only to the triplet-S neutron-proton potential.

STA.08:002

Stanford U. [High-Energy Physics Lab.] Calif.

OPTICAL MODEL ANALYSIS OF K^+ MESON SCATTERING (Abstract), by G. Igo, D. G. Ravenhall and others. [1957] [1]p. (Sponsored jointly by [Office of Naval Research], Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116; continuation of AF 18(600)646]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Boulder, Colo., Sept. 5-7, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 311, Sept. 5, 1957.

The scattering of K^+ mesons of energies near 150 mev and in the interval 40 to 100 mev has been analyzed in terms of a complex potential, $(V + iW)/[1 + \exp[(r - r_0)/d]]$. The quantities r_0 and d were taken to be $1.07 A^{1/3}$ and 0.47 fermi, respectively. An exact phase shift analysis has been made for each element in the emulsion and at several energies in order to arrive at a suitable energy average for comparison with events detected in emulsions. Utilizing a repulsive potential, an adequate fit to the differential cross section for elastic scattering, the total cross section, and the inelastic cross section was obtained with V and W equal to 25 and -10.6 mev, respectively. At the lower energies, the best fit was obtained with V and W equal to 20 and -4.9 mev. When V is made attractive, the fits to the differential cross section for elastic scattering are less good particularly in the region of the interference minimum. The improvement over previous calculations of this process lies in its inclusion of W in the elastic cross section.

STA.08:003

Stanford U. [High-Energy Physics Lab.] Calif.

DETERMINATION OF THE FORM FACTOR OF THE DIFFERENCE BETWEEN THE PROTON AND THE NEUTRON MAGNETIC MOMENTS (Abstract), by W. K. H. Panofsky and E. A. Ailton. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

STA.08:004 - STA.08:006

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 391, Dec. 19, 1957.

Study has been made of inelastic electron scattering with the primary and secondary electron energies programed against each other to maintain the energy of the pion-nucleon system at the "resonance" energy. At this energy setting and a laboratory angle of 75° for the scattered electron, the momentum transfers can be varied from ~200 to 470 mev/c, thus exploring the form factor for the matrix element in question. This measurement can give independent evidence concerning the extent in space of the proton and neutron magnetic moment distributions, since the Chew-Low and dispersion theory matrix elements are proportional to the algebraic difference in the proton and neutron magnetic moments. Under the conditions mentioned the theoretical value for a point nucleon of the cross section for inelastic scattering of an electron leaving the proton-pion system at the energy corresponding to the 3/2, 3/2 resonance is $3.0 \times 10^{-34} \text{ cm}^2 \text{ sterad}^{-1} \text{ mev}^{-1}$. The experimental measurements deviate progressively from this value toward $(1.35 \pm 0.13) \times 10^{-34} \text{ cm}^2 \text{ sterad}^{-1} \text{ mev}^{-1}$ at a momentum transfer of 470 mev/c. The figure is in agreement if both the neutron and proton are given radii corresponding to the electromagnetic radius of the proton.

STA.08:004

Stanford U. [High-Energy Physics Lab.] Calif.

EFFECTS OF FINITE NUCLEAR SIZE IN ELECTRODISINTEGRATION EXPERIMENTS (Abstract), by W. C. Barber. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 389, Dec. 19, 1957.

The usual expressions giving the cross section for electrodisintegration reactions in terms of the photodisintegration cross sections are not valid when the nuclear size is comparable with the wavelength associated with the momentum transfer. Measurements of the ratio of the yields of C^{11} produced by the $C^{12}(e,e'n)$ and $C^{12}(\gamma,n)$ have been made using primary electrons of energy from 24 to 150 mev. At the higher energies a comparison of this ratio with theory requires consideration of the finite nuclear size. An approximate size correction has been included in the theory with the result that the comparison of experiment and theory is consistent, at all primary energies, with the interpretation that the transitions producing the reactions are predominantly electric dipole.

pole. A similar comparison of theory and the experimental yield ratios of the reactions $E^{19}(e,e'2p)N^{17}$ and $F^{19}(\gamma,2p)N^{17}$ measured by Reagon indicate these transitions are predominantly electric quadrupole.

STA.08:005

Stanford U. [High-Energy Physics Lab.] Calif.

ELECTRON DISINTEGRATION OF ELEMENTS FROM $Z = 3$ TO $Z = 79$ (Abstract), by H. W. Kendall and U. Meyer-Berkhout. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 378, Dec. 19, 1957.

Yields of protons and deuterons from electron disintegration of a series of elements from Li^6 to Ta^{181} have been studied. Targets were bombarded with 500-mev electrons and disintegration fragments of momentum $p < 550$ mev/c, after momentum analysis with a 36-in. magnetic spectrometer, were detected in plastic or NaI(Tl) scintillation counters. Angular distributions of protons and deuterons in the range of laboratory angles from 40° to 135° were determined absolutely by comparison with known elastic electron-scattering cross sections. Proton and deuteron yields are proportional to Z , and the ratio of deuteron to proton differential cross sections (taken either at equal particle energy or equal momentum) appears to be approximately constant with a value in the range 0.07-0.12. The results are interpreted in terms of a transverse electron-nucleus interaction, which is effectively a high-energy photodisintegration process. This process gives rise to high-energy protons and neutrons originating in the nuclear volume. The large deuteron yields are consistent with a pickup reaction at the nuclear surface in analogy with high-energy (p,d) and (n,d) reactions. No detailed theory explains the high deuteron yields, which are also observed in other processes.

STA.08:006

Stanford U. [High-Energy Physics Lab.] Calif.

ELECTRON SCATTERING STUDY OF Li^6 (Abstract), by R. Hoistadter and G. R. Burleson. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

STA.08:007 - STA.08:009

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 390, Dec. 19, 1957.

The nucleus Li^6 has been investigated with electrons of energy 426 mev scattered in the angular range 33° - 50° . Elastically scattered electrons are resolved from electrons which have been scattered with excitation of the first level, at 2.189 mev, and higher levels. To achieve this resolution in the presence of large inelastic cross sections, the elastic peaks were approximately 0.25% wide (full width) at half maximum. An analysis of the angular distribution has been carried out with the Born approximation and several possible nuclear models. An independent particle shell model, using an infinite harmonic well, fits the experimental data if the rms radius is chosen to be $2.2 \pm 0.2 \times 10^{-13}$ cm. A Gaussian will also fit moderately well with a similar radius, but this charge distribution is not significantly different from that of the shell model.

STA.08:007

Stanford U. [High-Energy Physics Lab.] Calif.

FORM FACTOR INVESTIGATION OF THE NEUTRON BY HIGH-ENERGY ELECTRON SCATTERING (Abstract), by M. R. Yearian and R. Hofstadter. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 389, Dec. 19, 1957.

The magnetic form factor of the neutron can be investigated through a study of the inelastic continuum of electrons scattered from deuterons at high momentum transfers. The inelastic spectrum has been compared with elastic electron scattering from free protons at 500 mev (75° - 135°) and at 600 mev (135°). The inelastic spectra have been corrected for electron-pion production, for contamination by negative pions, and for shape distortion due to bremsstrahlung. The shapes of the spectra are roughly similar at all angles and agree well with predictions of a theory due to Jankus. The present results are: (1) irrespective of the details of applicable theories, the neutron's magnetic cloud is extended and is not a point; (2) the neutron's magnetic size and shape are approximately the same as those of the proton; and (3) the differences between the neutron and the proton can be determined from the present data upon development of an accurate theory of electro-disintegration of the deuteron.

STA.08:008

Stanford U. [High-Energy Physics Lab.] Calif.

FORM FACTOR STUDIES OF THE PROTON AT HIGH ENERGIES (Abstract), by F. Bumiller and R. Hofstadter. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 390, Dec. 19, 1957.

Elastic electron scattering experiments have been carried out against protons in CH_2 at energies of 500, 550, 575, 600, 650 mev between laboratory scattering angles of 75° and 135° , in order to investigate finite size effects in the proton. The new experiments attempt to distinguish between several different models of density distribution fitting the earlier data. Two methods of comparison with phenomenological models have been used. The first (I) employs a plot of F^2 versus q^2 where $F_1 = F_2 = F$. The second method (II) concentrates on the experimental ratio of $\sigma_{75^\circ}/\sigma_{135^\circ}$, which is sensitive index distinguishing between the various models and, furthermore, does not require a knowledge of absolute cross sections. The results of methods (I), (II) are as follows: (a) the present experiments are consistent with the earlier ones as far as the earlier ones go; (b) the newer data distinguish between the models previously proposed; (c) the most favorable case among the exponential, Gaussian, hollow exponential, and Yukawa I, II models is the exponential with rms size $r_e = r_m = 0.80 \times 10^{-13}$ cm; and (d) absolute cross sections are in good agreement with the exponential model.

STA.08:009

Stanford U. [High-Energy Physics Lab.] Calif.

INELASTIC SCATTERING OF ELECTRONS IN HYDROGEN (Abstract), by E. A. Alltun and W. K. H. Panofsky. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 391, Dec. 19, 1957.

Inelastic scattering in hydrogen leading to pion production gives additional information as compared to

STA.08:010 - STA.08:012

photopion production since: (a) Longitudinal matrix elements contribute to the process. (b) The relation between production by real and virtual photons is different depending on the multipole order of the meson-nucleon system. (c) Contrary to the situation in photoproduction, the momentum transfer to the meson-nucleon system can exceed the energy transfer; "structure" effects in the matrix elements can thus be studied. All these effects are largest at large electron angles. For this reason, a procedure has been developed and tested to study the inelastic scattering process by observing the scattered electrons at a large angle. The contributions from secondary electrons due to large-angle bremsstrahlung can be calculated theoretically and are subtracted. Contributions due to converted γ rays from π^0 production, due to electron-positron pairs and due to high-energy π^- mesons produced by real and virtual photons, can be eliminated by studying the electron yield as a function of a radiator placed in the primary electron beam. This method has been tested and gives internally consistent results. Absolute cross sections are obtained by comparison with the elastic cross sections measured in the same apparatus.

STA.08:010

Stanford U. [High-Energy Physics Lab.] Calif.

INELASTIC SCATTERING OF 500-MEV ELECTRONS FROM Li^6 AND Li^7 (Abstract), by U. Meyer-Berkhout and R. Hofstadter. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 390, Dec. 19, 1957.

An experiment was carried out in which 500-mev electrons have been scattered from enriched Li^6 and ordinary Li^7 between scattering angles of 60° and 135° in the laboratory system. The cross section integrated over the inelastic continuum at these large momentum transfers has been compared with the free proton cross section at the corresponding angles. The results are obtained by assuming that the scattering from the bound nucleons in first approximation can be considered as incoherent. The measured ratios, $\sigma_{\text{Li}}/\sigma_p$, seem to indicate that protons and neutrons in lithium make comparable contributions to the magnetic scattering at the larger angles. It is difficult at present to find the neutron's actual contribution to the cross section, since theoretical estimates of corrections, allowing for the momentum distribution of nucleons, final state interaction, meson production and exchange, are uncertain.

Therefore, only the quantity $R = 1/N[\sigma_{\text{Li}}/\sigma_p] - 3$, where $N = 3, 4$ for Li^6, Li^7 , respectively, has been derived from the data. R should be equal to σ_N/σ_p , if incoherency applies and if the corrections are negligible. If it is set tentatively that $\sigma_N/\sigma_p = R$, then σ_N/σ_p is found to be (1.0 ± 0.4) at $135^\circ, 500 \text{ mev}$, and decreases to (0.5 ± 0.2) at $60^\circ, 500 \text{ mev}$.

STA.08:011

Stanford U. [High-Energy Physics Lab.] Calif.

MULTIPLE SCATTERING OF 600-MEV ELECTRONS BY A THIN ALUMINUM FOIL (Abstract), by R. C. Smith, R. E. Taylor and others. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 389, Dec. 19, 1957.

A measurement has been made of the multiple scattering of a collimated beam of 600-mev electrons by a 3-mil (0.0205 gm/cm^2 ; 8.6×10^{-4} rad length) aluminum foil. The scattered electrons pass through a glass plate at a distance of 40 ft and the location of the scattered electrons is determined by a densitometer measurement of the darkening of the plate. The linearity of darkening is established by making a series of similar measurements with different total numbers of incident electrons. The resulting multiple-scattering curve has a mean width of $0.70 \pm 0.05 \text{ mc}^2/E_0$. The accuracy of measurement does not allow it to be distinguished from a Gaussian. This number is in agreement with the $0.74 \text{ mc}^2/E_0$ value predicted by Moliere theory.

STA.08:012

Stanford U. [High-Energy Physics Lab.] Calif.

PHOTOPROTONS FROM C^{12} (Abstract), by W. R. Dodge and W. C. Barber. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 377, Dec. 19, 1957.

STA.08:013 - STA.08:015

Proton energy and angular distributions from the electro- and photodisintegration of C^{12} have been measured with an 18-in., 120° double-focusing magnetic spectrometer. Nine KI scintillation crystals mounted on the focal plane of the spectrometer provide simultaneous measurement of nine proton momentum groups. Preliminary measurements taken with a primary energy of 30 mev indicate a proton angular distribution peaked at nearly 90° slightly skewed in the forward direction for both electro- and photodisintegration and a sharp peak in the energy spectrum corresponding to photon absorption at the giant resonance with transitions to the ground state of B^{11} . There is also evidence for other proton levels.

STA.08:013

Stanford U. [High-Energy Physics Lab.] Calif.

SCATTERING OF 420 MEV ELECTRONS FROM SOME NUCLEI OF THE FIRST p-SHELL (Abstract), by H. Ehrenberg, U. Meyer-Berkhout and others. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 390, Dec. 19, 1957.

Measurements of the elastic scattering cross sections of 420 mev electrons at various scattering angles have been performed for C^{12} and O^{16} and furnish new information on the shape and size of those nuclei. The experimental results were obtained as part of a program to study the charge distributions of the nuclei of the first p-shell and are compared with the predictions of a theoretical phase shift analysis derived for the harmonic well independent particle model of the nucleus. Pronounced diffraction minima in the angular distributions were observed for C^{12} and O^{16} . The new data on C^{12} are in excellent agreement with what one would expect from earlier measurements performed at 183 mev. Best fits of the experimental data with theoretical angular distributions make it possible to check the shell model predictions for the parameter α related to the number of protons in the first p-shell and furthermore give the value of the parameter a_0 , which is related to the curvature of the infinite harmonic well. a_0 varies within the p-shell. Values of α and the rms radius of the charge distribution used in the best fits are given. The freedom in choosing those parameters are discussed. Data on Li^6 and Be^9 are included in the discussion.

STA.08:014

Stanford U. [High-Energy Physics Lab.] Calif.

NUCLEAR AND NUCLEON SCATTERING OF HIGH-ENERGY ELECTRONS, by R. Hofstadter. [1957] [86]p. incl. diagrs. tables, refs. [Rept. no. HEPL-126] (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Published in Ann. Rev. Nuclear Science, v. 7: 231-316, 1957.

The purpose of this paper is to present the fundamental ideas of the important scattering formulas by working out sample derivations, to collect useful results in scattering theory, and to bring the experimental and theoretical results up-to-date.

STA.08:015

Stanford U. [High-Energy Physics Lab.] Calif.

INVESTIGATION OF THE CHARGE FORM FACTOR OF THE PROTON (Abstract), by F. Bumiller and R. Hofstadter. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 50, Jan. 29, 1958.

An examination of the proton's charge structure function (=Dirac form factor, F_1) has been carried out by scattering electrons from protons in CH_2 at electron energies 200 mev and 600 mev in the laboratory system. The method takes advantage of the fact that at small scattering angles the ratio of cross sections ($\sigma_{200}/\sigma_{600}$) is sensitive to F_1 and practically independent of the magnetic form factor F_2 . Thus very little knowledge of the magnetic form factor is required to determine precise features of the F_1 distribution. When the results are, for convenience, put in the form of a phenomenological charge-density distribution, the exponential model with rms radius 0.80×10^{-13} cm, gives a good fit. This result indicates that the electrical size of the proton is the same as the magnetic size, at the momentum-transfer values presently investigated. The data can also be presented equivalently, without referring to a model, in the form of phenomenological structure functions.

STA.08:016 - STA.08:019

STA.08:016

Stanford U. [High-Energy Physics Lab.] Calif.

STUDY OF THE MAGNETIC FORM FACTOR OF THE NEUTRON AT 600 MEV (Abstract), by M. R. Yearian and R. Hofstadter. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 50, Jan. 29, 1958.

Further experimental investigation of the neutron's magnetic form factor has been continued at 600 mev. The deuteron electrodisintegration data can be compared with theories of Jankus and Blankenbecler with inclusion of the proton and neutron form factors. When the form factors are included, the theoretical shape of the inelastic continuum changes with respect to the original theoretical shape calculated by Jankus for points. The present results at 600 mev are compared with a model which fits the 500-mev data. From these results, the neutron's magnetic cloud is definitely not a point and is of approximately the same size as the proton magnetic cloud. Possible differences between the neutron and proton will be discussed.

STA.08:017

Stanford U. [High-Energy Physics Lab.] Calif.

MEASUREMENT OF THE TOTAL ABSORPTION COEFFICIENT OF LONG-LIVED NEUTRAL K PARTICLES, by W. K. H. Panofsky, V. L. Fitch and others. [1958] [5]p. incl. diagrs. tables, refs. [Rept. no. HEPL-128] (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and [Air Force Office of Scientific Research under N6onr-25116])

Unclassified

Published in Phys. Rev., v. 109: 1353-1357, Feb. 15, 1958.

Long-lived neutral K particles have been detected electronically and their total absorption cross section in copper has been measured in good geometry. The observed value of $\sigma = 1.12 \pm 0.25$ barns is compared with the corresponding values for charged-K-particle cross sections. (Contractor's abstract)

STA.08:018

Stanford U. High-Energy Physics Lab., Calif.

INCOHERENT ELECTRON SCATTERING FROM THE

NUCLEONS IN BERYLLIUM AND CARBON AND THE MAGNETIC SIZE OF THE NEUTRON, by H. F. Ehrenberg and R. Hofstadter. [1958] [7]p. incl. illus. diagrs. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Published in Phys. Rev., v. 110: 544-550, Apr. 15, 1958.

The electron scattering at high momentum transfer has been measured from the nucleons in Be, in C, and from free proton. The data yield the cross section of the average nucleon and of the neutron in relation to that of the proton. $\sigma_n/\sigma_p(\theta)$ is found to be 1.16 ± 0.3 at 500 mev and 135° ; it decreases, as expected, for smaller angles and lower energies. If the assumption is made that meson-exchange effects and interactions in the final state are not important, the form factors obtained indicate an apparent root-mean-square radius of the neutron's magnetic-moment distribution of $(0.53 \pm 0.15) \times 10^{-13}$ cm. It is possible that the apparent small size of the neutron in Be and C is due to the neglect of meson-exchange effects and interactions in the final state. The present result is smaller than a neutron size, given by Yearian and Hofstadter, who compared the cross sections of deuteron and proton and found equal sizes for neutron and proton. If one accepts the latter result, the present experiment can be used to yield a measure of the above neglected effects. (Contractor's abstract)

STA.08:019

Stanford U. High-Energy Physics Lab., Calif.

MAGNETIC FORM FACTOR OF THE NEUTRON, by M. R. Yearian and R. Hofstadter. [1958] [13]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Published in Phys. Rev., v. 110: 552-564, Apr. 15, 1958.

Electron scattering from the bound neutron and proton in the deuteron has been studied at various scattering angles between 75° and 135° for 500-mev and 600-mev electrons. A comparison of these scattering cross sections with those of the free proton permits a determination of the density distribution of the magnetic cloud around the neutron. By using theories developed by Jankus and Blankenbecler, the root-mean-square radius of the neutron is shown to lie between the limits 0.80×10^{-13} cm and 0.90×10^{-13} cm. The choice between these radii depends on whether the deuteron total cross sections or differential (peak) cross sections are compared with the protonic scattering cross section. Since presently available theory has not yet developed sufficiently to decide definitely between these possibilities, the root-mean-square size may be taken to be

STA.08:020 - STA.08:022

$(0.85 \pm 0.10) \times 10^{-13}$ cm with small error. The neutron's magnetic cloud clearly does not have the small size obtained by measurement of its charge cloud from experiments on the neutron-electron interaction, and this anomaly challenges the present concepts of nucleon size. (Contractor's abstract)

STA.08:020

Stanford U. High-Energy Physics Lab., Calif.

ELECTROMAGNETIC STRUCTURE OF THE PROTON AND NEUTRON, by R. Hofstadter, F. Bumiller, and M. R. Yearian. [1958] [16]p. Incl. diagrs. refs. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr 25116]) Unclassified

Published in Rev. Modern Phys., v. 30: 482-497, Apr. 1958.

A review is presented of the high energy scattering of electrons from protons and deuterium in order to establish the structure of the nucleons. It is found that the two form factors F_1 and F_2 introduced in the Rosenbluth point scattering curve are equal for the proton and that F_2 for the neutron is the same as that for the proton but that F_1 for the neutron is zero. The rms value for the charge distribution of the nucleons is found to be 0.80×10^{-13} cm. Scattering at high momentum transfer and at large angles measures the scattering due to the magnetic moment and yields a ratio for the neutron to proton scattering of .45 which indicates that the magnetic moment of the neutron is not point distribution but that the magnetic moment distribution of both nucleons is the same. An exponential model of the charge distribution is the best fit for the form factor distributions, however it is not possible to discount a model which has a negative charge singularity at the origin and a monotonic charge distribution such as the Yukawa potential elsewhere.

STA.08:021

Stanford U. [High-Energy Physics Lab.] Calif.

PRODUCTION OF π^+ MESONS BY POLARIZED BREMSSTRAHLUNG AT 240, 335, AND 373 MEV (Abstract), by R. F. Mozley, R. E. Taylor, and F. R. Tangherlini. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 196, May 1, 1958.

Studies have been made of π^+ meson production at 90° cm angle and photon energies of 240, 335, and 375 mev, using polarized bremsstrahlung from the 600-mev electron beam of the Stanford linear accelerator. The polarized bremsstrahlung beam was obtained by selecting the bremsstrahlung produced in a 3-mil aluminum radiator at an angle of approximately $1/1000$ radian from the electron beam direction. To estimate the amount of polarization the aperture function and a measured value of the multiple scattering are folded into the polarization calculated by May using a relativistic small angle approximation. The ratio of meson production along and at right angles to the electric field vector is measured and compared with the values predicted by the relativistic dispersion relation.

STA.08:022

Stanford U. [High-Energy Physics Lab.] Calif.

PROTONS FROM THE PHOTO-AND ELECTRODIS-INTEGRATION OF C^{12} AND Al^{27} (Abstract), by W. C. Barber, W. R. Dodge, and V. J. Vanhuyse. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 173, May 1, 1958.

The magnetic spectrometer previously described has been used to study the protons ejected from targets bombarded by the beam of the Stanford 40-mev linear electron accelerator. Either the electron beam alone or a combination of the electron beam plus the bremsstrahlung from a thin radiator can be incident on the target.

The protons from C^{12} have a narrow peak in the energy distribution at 6 mev corresponding with photon absorption at the giant resonance followed by transitions to the ground state of B^{11} . A high-energy tail of protons extends to the endpoint of the photon spectrum and shows evidence for subsidiary peaks near 8.5 and 13.5 mev. The angular distribution of those protons in the neighborhood of 6 mev fits the form $1 + 1.3 \sin^2 \theta (1 + 0.3 \cos \theta)^2$ for either the electron- or photon-induced processes. The protons from aluminum have a broad energy distribution with a peak near 4 mev. As with carbon, the high-energy tail shows evidence of structure. The angular distribution changes gradually from nearly isotropic at 4 mev to significantly forward at 13 mev.

STA.08:023 - STA.08:026

STA.08:023

Stanford U. [High-Energy Physics Lab.] Calif.

MEASUREMENT OF SHUNT IMPEDANCE OF A CAVITY, by K. B. Mallory. [1958] [4]p. incl. diagrs. [Rept. no. HEPL-116] (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under N6onr-25116)

Unclassified

Published in Jour. Appl. Phys., v. 29: 790-793, May 1958.

The equivalent shunt impedance of a lightly coupled transmission cavity can be measured by inserting very small perturbing elements and using a simple bridge method to detect small shifts of transmission phase. A simple graphical procedure is developed for the interpretation of these measurements. It is shown that the procedure measures directly the shunt impedance R of the cavity, rather than the geometric quantity R/Q . Experimental results are presented for one such cavity, which show that phase information thus obtained is about 100 times as sensitive as amplitude information normally obtained from a transmission cavity. (Contractor's abstract)

assumed for the proton, then the data appear to require an rms radius of the magnetic moment of the neutron of about 1.1×10^{-13} cm, based on an exponential model. Nucleon recoil corrections are still somewhat uncertain. (Contractor's abstract)

STA.08:025

Stanford U. [High-Energy Physics Lab.] Calif.

ELECTRON SCATTERING FROM THE DEUTERON AND THE NEUTRON-PROTON POTENTIAL (Abstract), by J. A. McIntyre and G. R. Burleson. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 268, June 19, 1958.

Electrons at energies of 400 and 500 mev have been scattered by deuterons with accuracy higher than that attained in previous measurements. The results have been analyzed using Jankus' static calculation of electron-deuteron scattering. The sizes of the proton and the neutron in the deuteron have been introduced according to the analysis of Yennie, Levy, and Ravenhall. For direct comparison with experimental results, three deuteron wave functions satisfying the usual requirements have been substituted into Jankus' formula. Two of the wave functions are generated by Yukawa-type neutron-proton potentials while the other results from a repulsive-core (Gartenhaus) potential. The effect of the proton size has been eliminated experimentally by taking ratios between the electron-deuteron and electron-proton scattering. The neutron size has been assumed to be negligibly small. Using the analysis of the data outlined in the foregoing, the experiments agree with the repulsive-core deuteron scattering and do not agree with either of the Yukawa deuterons. This result tests only the S-state charge distribution of the deuteron.

STA.08:024

Stanford U. High-Energy Physics Lab., Calif.

FORM FACTOR OF THE PHOTOPION MATRIX ELEMENT AT RESONANCE, by W. K. H. Panofsky and E. A. Ailion. [1958] [11]p. incl. diagrs. tables, refs. [Rept. no. HEPL-132] (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Published in Phys. Rev., v. 110: 1155-1165, June 1, 1958.

The inelastic scattering of electrons in hydrogen leading to pion formation has been examined. Measurements were carried out in which a hydrogen target was bombarded by electrons of energy E_1 with secondary electrons of energy E_2 being detected by a magnetic analyzer at a fixed angle of 75° . The energies of E_1 and E_2 were programmed together such that the pions were produced at a constant energy near the peak of the pion-nucleon resonance in the $(3/2, 3/2)$ state. At the same time the momentum transfer to the pion-nucleon system was varied. Special procedures were developed to eliminate contributions from competing processes. Approximately three fourths of the observed cross section corresponds to magnetic-dipole absorption of the incident virtual photon. The momentum transfer dependence can be interpreted in terms of a form factor of the difference between the magnetic moments of the neutron and proton. If the electron-scattering radii are

STA.08:026

Stanford U. High-Energy Physics Lab., Calif.

MEASUREMENTS OF THE ENERGY AND ANGULAR DISTRIBUTIONS OF PHOTOPROTONS, by W. C. Barber, W. R. Dodge, and V. J. Vanhuyse. [1958] [4]p. incl. diagrs. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Published in Internat'l. Congress on Nuclear Phys., Paris (France) (July 7-12, 1958), Paris, Dunod, 1959, p. 630-633.

STA.08:027 - STA.08:030

A magnetic spectrometer has been used in connection with the Stanford 40-mev linear electron accelerator to study the energy and angular distributions as well as the excitation functions of photoprotons from targets of C, Al, In, and Ta. In general the results indicate enough structure in the energy distribution that they cannot be explained by a single resonance modified by barrier effects. For C an analysis of the proton distributions leads to a cross section very similar to the $^{12}\text{C}(\gamma, n)$ cross section curve, as is expected from charge symmetry of nuclear forces. For In and Ta the Coulomb effects are very important, and the excitation functions prove that the protons are produced by photons of higher energy than those which produce photoneutrons. The high energy and large numbers of photoprotons from these elements indicate that they are produced in a "direct" process. (Contractor's abstract)

STA.08:027

Stanford U. High-Energy Physics Lab., Calif.

MULTIPLE SCATTERING OF 600-MEV ELECTRONS IN THIN FOILS, by R. F. Mozley, R. C. Smith, and R. E. Taylor. [1958] [3]p. incl. illus. diagrs. table. (Rept. no. HEPL-138) (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])
Unclassified

Published in Phys. Rev., v. 111: 647-649, July 15, 1958.

The beam of the Stanford Mark III linear accelerator has been used to measure the width of the angular distribution of electrons multiply scattered in thin Be, Al, and Au foils. The results are in agreement with the prediction of the Molière theory. (Contractor's abstract)

STA.08:028

Stanford U. High-Energy Physics Lab., Calif.

LARGE-ANGLE ELECTRON PAIR PRODUCTION FROM HYDROGEN, by B. Richter. [1958] [3]p. incl. diagrs. [Rept. no. HEPL-146] (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])
Unclassified

Published in Phys. Rev. Letters, v. 1: 114-116, Aug. 1, 1958.

The pair production cross-section from protons was measured by detecting the 70 mev positrons produced at 90° to a 137 mev peak energy bremsstrahlung beam. It was found to be 0.96 ± 0.14 of a value predicted by Bjorken, Drell, and Frautshi, and could be interpreted

as setting an upper limit of about 0.9 fermi to the distance at which the present theory of quantum electrodynamics breaks down.

STA.08:029

Stanford U. High-Energy Physics Lab., Calif.

MAGNETIC FORM FACTOR OF THE NEUTRON AT 600 MEV, by M. R. Yearian and R. Hofstadter. [1958] [6]p. incl. diagrs. tables, refs. (Rept. no. HEPL-139) (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])
Unclassified

Published in Phys. Rev., v. 111: 934-939, Aug. 1, 1958.

The study of electrons scattered inelastically from the deuteron has been extended to 600 mev. Data at 500 mev were reported in an earlier paper. Results are presented for seven scattering angles between 45° and 135°. A comparison of the deuteron's cross section at these angles with the corresponding free proton cross section permits a determination of the form factor associated with the magnetic moment distribution of the neutron. Two different methods of analyzing the data are described, and the rms radius of the neutron for an exponential density distribution of the magnetic cloud can be shown to lie between the limits of 0.75×10^{-13} cm and 0.95×10^{-13} cm. The rms radius of the neutron may be taken to be $(0.80 \pm 0.10) \times 10^{-13}$ cm and is very close to the value found for an exponential model of the magnetic cloud in the proton.

STA.08:030

Stanford U. High-Energy Physics Lab., Calif.

ELECTRODISINTEGRATION OF Be^9 AND C^{12} , by W. C. Barber. [1958] [9]p. incl. diagrs. tables, refs. [Rept. no. HEPL-134] (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])
Unclassified

Published in Phys. Rev., v. 111: 1642-1650, Sept. 15, 1958.

Yields from the reactions $\text{Be}^9(e, e'n)$ and $\text{Be}^9(\gamma, n)$, as well as the relative yields from $\text{C}^{12}(e, e'n)\text{C}^{11}$ and $\text{C}^{12}(\gamma, n)\text{C}^{11}$, were measured under conditions which permitted a comparison of the relative effects of electrons and bremsstrahlung from electrons in producing nuclear reactions. The primary electron energies were from 6 to 17 mev in the case of Be, and 24 to 145 mev in the case of C. Comparison of the experimental results with the theory of electrodisintegration gives information

STA.08:031 - STA.08:033

about the multipole order of the electromagnetic transitions involved. The Be^9 results agree with theory if the reaction mechanism is predominantly electric-dipole. For C^{12} , a mixture of 92% electric-dipole with 8% electric-quadrupole intensities gives agreement with theory over the energy range 28-145 mev, provided that the finite size of the C nucleus is taken into account. The method of considering the finite nuclear size in the theory is presented, and the results previously obtained by Reagan for the reactions $\text{F}^{19}(\text{e}, \text{e}'2\text{p})\text{N}^{17}$ and $\text{F}^{19}(\gamma, 2\text{p})\text{N}^{17}$ are shown to be in good agreement with the modified theory for an electric-quadrupole transition.

STA.08:031

Stanford U. High-Energy Physics Lab., Calif.

HIGH-ENERGY ELECTRON SCATTERING FROM LITHIUM-6, by G. R. Burleson and R. Hofstadter. [1958] [5]p. incl. diagrs. tables, refs. [Rept. no. HEPL-143] (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Published in Phys. Rev., v. 112: 1282-1286, Nov. 15, 1958.

The Li^6 nucleus has been studied at 426 mev by electron scattering methods between laboratory angles of 33° and 57.5° . Absolute values of the Li^6 cross sections have been obtained by comparison with scattering measurements made on the proton at 426 mev and 40° . Unique values of the experimental form factors are given in tabular form. The results are analyzed in terms of various possible charge distributions. Several examples of models showing a good fit are presented and appropriate radius and skin thickness values are given. Several unsuccessful models are also discussed. (Contractor's abstract)

STA.08:032

Stanford U. [High-Energy Physics Lab.] Calif.

MAGNETIC QUADRUPOLE WITH RECTANGULAR APERTURE (Abstract), by L. N. Hand and W. K. H. Panofsky. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 421, Dec. 29, 1958.

A magnetic quadrupole lens has been designed and is being built which defines the desired field shape by a current distribution on the inside faces of a rectangular box; the current emerges on one set of opposite faces and returns along the other set. The motive for such a design is the need for a quadrupole lens in a strong-focusing system where the radial excursion in the focusing plane generally greatly exceeds the excursion in the defocusing plane. The particular design of 40-in. length employs an aperture of $23 > < 4$ in. at a gradient of 400 gauss/in. This quadrupole in combination with a conventional $6 > < 4$ in. quadrupole and a bending magnet constitutes a 1 bev/c magnetic spectrometer of 0.013-sterad aperture and a target-to-focus distance of 20 ft. It is intended to correct the aberration of the quadrupole by differential shunting of the windings.

STA.08:033

Stanford U. [High-Energy Physics Lab.] Calif.

PERFORMANCE OF A DOUBLE-FOCUSING, ZERO-DISPERSION SPECTROMETER (Abstract), by R. A. Alvarez, K. L. Brown and others. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 421, Dec. 29, 1958.

The spectrometer, which will focus singly charged particles of momentum $p < 425$ mev/c, has been constructed and tested using the Stanford Mark III linear accelerator beam as a physical ray-tracing device. The spectrometer consists of two identical magnets, $n \approx 0.27$, 110° deflecting, 30-in. radius of curvature, bending the particles in the same sense. It has been found that the double-focusing, zero-dispersion condition is obtained for particles of ~ 300 mev/c momentum with both source and image positions symmetrically located $47\frac{1}{2}$ in. from the magnets. This gives a useful solid angle of $\Omega_0 \sim 0.0055$ sterad for particles with central momentum p_0 originating from a point on the central axis. The solid angle does not change noticeably for particles originating from points as far as $\pm \frac{1}{2}$ in. from the central axis. It is believed that the addition of pole-tips will increase the effective solid angle of the system. The momentum acceptance $\Delta p/p_0$ is in excess of $\pm 4\%$ with a useful solid angle of ~ 0.0015 sterad at the 4% points. For a point source and the solid angles and momentum acceptances given above, second-order aberrations prevent all particles from coming to a point focus, but 90% fall within a 2-in. diam. circle at the first-order focus.

STA.08:034 - STA.08:036

STA.08:034

Stanford U. [High-Energy Physics Lab.] Calif.

PHOTOPRODUCTION OF POSITIVE PIONS IN HYDROGEN IN THE ANGULAR RANGE $7^\circ < \theta_{\text{center of mass}} < 27^\circ$ AND PHOTON ENERGY RANGE $220 \text{ MEV} < k < 390 \text{ MEV}$, by A. J. Lazarus, W. K. H. Panofsky, and F. R. Tangherlini. [1958] [9]p. incl. illus. diagrs. refs. [Rept. no. HEPL-151] (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 421, Dec. 29, 1958.

Also published in Phys. Rev., v. 113: 1330-1338, Mar. 1, 1959.

Relative measurements of the cross sections for the production of positive pions by photons on protons have been carried out in the angular range $7^\circ < \theta_{\text{center-of-mass}} < 27^\circ$ for photon energies of 220, 300, 350, and 390 mev. Positive pions were detected via the decay positron from the $\pi^+-\mu^+-e$ chain which was observed in a series of gates following a pulse of photons and electrons from the Mark III linear accelerator. The relative cross sections at these energies are 202 ± 28 , 168 ± 23 , 246 ± 37 , and 395 ± 90 , in arbitrary units. The angular distribution in the range indicated above is uniform within $\pm 7\%$ statistics. The results have been compared with new dispersion theory calculations using a range of values of the coupling constant and resonance energy. The experimental data at these small angles are in good agreement with the calculations; however, the fit of the calculations with available data at larger angles is not satisfactory. It is shown that the fit in either case is substantially poorer if the so-called "retardation term," is omitted.

STA.08:035

Stanford U. [High-Energy Physics Lab.] Calif.

SCATTERING OF 200-MEV POSITRONS BY ELECTRONS (Abstract), by J. A. Poirier, D. M. Bernstein, and J. Pine. [1958] [1]p. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Presented at meeting of the Amer. Phys. Soc., California U., Los Angeles, Dec. 29-31, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 421, Dec. 29, 1958.

A beryllium target 2 g/cm^2 thick was bombarded by 200-mev positrons. A diffusion cloud chamber with a magnetic field was located behind the target and was used to detect recoil electrons from positron-electron scattering. In addition, the positron flux was measured by counting positron tracks in the chamber. About 10,000 cloud-chamber pictures have been obtained, at a positron intensity of about 60 per picture. Analysis of the pictures is in progress and the results will be presented. Attention is being concentrated on events in which the recoil electron energy is greater than 100 mev. It is expected that about 300 such events will be seen. These events will permit a measurement of the absolute differential cross section $d\sigma/dE^-$ for positron scattering as a function of recoil electron energy E^- . The integrated cross section for E^- in the range 100-200 mev will have a statistical uncertainty of about 6%. Systematic errors are expected to increase this uncertainty by about a factor of 2.

STA.08:036

Stanford U. High-Energy Physics Lab., Calif.

MULTICHANNEL SPECTROMETER DETECTOR, by H. W. Kendall. [1958] [5]p. incl. illus. diagrs. (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116]) Unclassified

Published in I.R.E. Trans. of Professional Group on Nuclear Science, v. NS-5: 190-194, Dec. 1958.

The use of a multichannel detector in the focal plane of a magnetic spectrometer effectively decouples the well-known reciprocal relation between spectrometer resolution and transmission applicable to single-channel detection. The Stanford 36-in. magnetic spectrometer is used in electron-scattering experiments in conjunction with the Mark III linear electron accelerator. In order to utilize the full momentum acceptance of the spectrometer ($\Delta p/p \approx 0.05$), we have constructed a 10-channel prototype of a 50-channel scintillation-Cerenkov detection system which will possess a resolution ($p/\Delta p \approx 1000$) close to the maximum obtainable from the spectrometer. The momentum channels are defined by small scintillation counters which detect ionizing particles, consisting primarily of high-energy pions and electrons. Electrons are distinguished from mesons by Cerenkov counters which back up blocks of 10 scintillators. A coincidence is required ($2\tau \approx 3 \times 10^{-8} \text{ sec}$) between a scintillation detector and the associated Cerenkov counter. A 256-channel computer-type ferrite core memory (Radiation Counter Laboratories Mark 20), divided into four manually or electronically selected blocks of 64 channels, is used to store the information from the counter array.

STA.08:037; STA.18:001;
STA.09:002, 003

The use of this large memory allows storage of correlated information in matrix form from two arrays of counters. (Contractor's abstract)

sizes from electromagnetic and other methods; sizes of nucleons; angular shapes and other methods of studying nuclear density distributions; nuclear surfaces; and general nuclear size problems.

STA.08:037

Stanford U. High-Energy Physics Lab., Calif.

A SODIUM IODIDE (TI) TOTAL ABSORPTION SPECTROMETER FOR HIGH ENERGIES, by A. W. Knudsen and R. Hofstadter. [1958] [4]p. incl. diags. (Rept. no. HEPL-137) (Sponsored jointly by Office of Naval Research, Atomic Energy Commission, and Air Force Office of Scientific Research under [N6onr-25116])

Unclassified

Published in I.R.E. Trans. of Professional Group on Nuclear Science, v. NS-5: 152-155, Dec. 1958.

A scintillation counter employing a 70-lb NaI(Tl) crystal and a Swiss (AfiF) multiplier phototube has been tested with electrons of energy up to 600 mev. The plot of pulse height vs energy of incident electrons is found to be linear up to the highest energy tested (600 mev). Energy resolution of 16% has been obtained at 350 mev. The crystal is 9 1/2 in. both in diameter and length. The incident radiation, which can be either electrons or gamma rays, induces a cascade electromagnetic shower within the mass of the crystal giving rise to light which enters the photomultiplier tube. Graphs showing linearity in energy response are presented as well as plots of line shape at constant energy of the incident particle. The procedure for obtaining line breadth semitheoretically is described, and the breadth so derived compared with the value obtained in actual practice. Details of the air-tight crystal enclosure and of the crystal-photomultiplier optical coupling system are shown. (Contractor's abstract)

STA.18:001

[Stanford U. High-Energy Physics Lab., Calif.]

INTERNATIONAL [CONFERENCE] ON NUCLEAR SIZES AND DENSITY DISTRIBUTIONS, Stanford U., Calif., Dec. 17-19, 1957. 1958 [173]p. incl diags. tables, refs. (Sponsored jointly by National Science Foundation, Office of Naval Research, and Air Force Office of Scientific Research)

Unclassified

Published in Rev. Modern Phys., v. 30: 412-584, Apr. 1958.

The Nuclear Sizes conference, believed to be the first international conference on this subject, was attended by U. S. and foreign scientists. It has been estimated that 300 or more physicists attended each of the various conference sessions. The last session was held in association with the American Physical Society. Among the topics discussed were sizes from nuclear methods;

STA.09:002

Stanford U. Microwave Lab., Calif.

FREE RADICALS IN BIOLOGICAL SYSTEMS, by M. S. Blois, Jr. and R. H. Sands. [Mar. 12, 1957] 7p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1511] and Irvine Foundation)

Unclassified

This study is concerned with the manner in which free radicals may in principle be expected to originate in biological systems. The possibilities of intracellular free radical production by (1) ordinary univalent oxidation-reduction of endogenous compounds, (2) enzymatic oxidations, and (3) ionizing radiations are considered. It is concluded that bona fide free-radical reactions appear to be present in biological systems, however, their origins may only be inferred. The existence of reversible oxidation-reduction systems employing free-radical intermediates is supported by the in vitro study of biological quinones and quinoid compounds. There are excellent theoretical reasons and some experimental evidence that enzyme-substrate reactions may involve free radicals. The production of radiation of free radicals in a living system, or for that matter even in a simple solution, has not been observed under normal conditions. Nevertheless of the 3 mechanisms discussed, the last possesses the greatest weight of indirect experimental corroboration. It is pointed out that the eventual understanding of the kinetics of free radicals and associated antioxidants will probably emphasize further the speed and precision with which living systems manipulate electrons.

STA.09:003

Stanford U. [Microwave Lab.] Calif.

FREE-RADICALS, ANTIOXIDANTS, AND CANCER, by M. S. Blois, Jr. [1957] 9p. refs. [AF 18(600)1511]

Unclassified

It has been hypothesized that free radicals play a role in some forms of chemical carcinogenesis, in radiation carcinogenesis, and in the general biological response to radiation. It is known that when an organism or tissue is irradiated, a very short period ensues in which the original energy is converted into ionization and excited states of molecules. In the next phase, a fraction of this energy is found in the form of free radicals (in particular CH₃·) which then either become paired off electronwise or undergo further reaction with molecules of the protoplasm. The resulting radicals have lifetimes that depend upon the resonance stability of the species,

STA.09:004 - STA.09:007; STA.10:003

being greater for the large polynuclear compounds. It is concluded that since insufficient data are available, the free-radical hypothesis cannot be vigorously evaluated.

STA.09:004

Stanford U. [Microwave Lab.] Calif.

PARAMAGNETIC RESONANCE SPECTRA OF SOME SEMIQUINONE FREE RADICALS, by M. Adams, M. S. Blois, Jr., and R. H. Sands. [1958] [3]p. incl. diagrs. table, refs. (ML rept. no. 428) (AFOSR-TN-58-90) (AF 18(600)1511) AD 148140 Unclassified

Also published in Jour. Chem. Phys., v. 28: 774-776, May 1958.

The paramagnetic resonance spectra of a number of semiquinone free radicals have been observed using a microwave electron spin resonance spectrometer. The character of the hyperfine structure, splitting constants, and g values for these radicals are tabulated. (Contractor's abstract)

STA.09:005

Stanford U. [Microwave Lab.] Calif.

ANTIOXIDANT DETERMINATIONS BY THE USE OF A STABLE FREE RADICAL, by M. S. Blois, Jr. [1958] [2]p. incl. diagr. (ML rept. no. 435) (AFOSR-TN-58-560) (AF 18(600)1511) AD 158378 Unclassified

Also published in Nature, v. 181: 1199-1200, Apr. 26, 1958.

The free radical α, α -diphenyl- β -picrylhydrazyl is stable for periods of weeks and shows a strong absorption band at 517 m μ which yields deep violet solutions if the concentration is at least 10^{-5} molar. The free radical oxidizes most common natural antioxidants and becomes decolorized. The SH groups of protein are oxidized but glucose, purines, pyrimidines or aromatic compounds with only a single hydroxyl group are not oxidized.

STA.09:006

Stanford U. Microwave Lab., Calif.

THE PARAMAGNETISM OF HYDROCARBON-CONC. H_2SO_4 SYSTEMS, by H. Kon and M. S. Blois, Jr. [1958] [6]p. incl. diagrs. (ML rept. no. 450) (AFOSR-TN-58-562) (AF 18(600)1511) AD 158380 Unclassified

Also published in Jour. Chem. Phys., v. 28: 743-744, Apr. 1958.

The optical and electron spin resonance spectra of systems of hydrocarbons in concentrated sulphuric acid solutions have been studied to determine if the paramagnetic ions are due to ionization or protonation. Absorption bands in the 550-760 m μ region have been observed for anthracene, naphthalene, and 3,4-benzopyrene. Positive ions are believed to be the source of the absorption and the formation of these ions can be understood not in terms of direct electron transfer from a neutral molecule but rather in terms of the atom localization energy necessary for protonation.

STA.09:007

Stanford U. [Microwave Lab.] Calif.

EPR SPECTROMETER OF VERY HIGH SENSITIVITY, by H. Misra. [1958] [5]p. incl. diagrs. (Sponsored jointly by Varian Associates, Palo Alto, Calif., and Air Force Office of Scientific Research under AF 18-(600)1511) Unclassified

Published in Rev. Scient. Instruments, v. 29: 590-594, July 1958.

A recording electron paramagnetic resonance absorption spectrometer of very high sensitivity, operating at a wavelength of 3 cm, is described. It is of the reflection-cavity-in-magic-T-bridge type, using a superheterodyne receiver. Its special features are: (1) a two-cavity klystron oscillator with superior frequency stability and more available power; (2) a synchrodyne system to derive local oscillator power, thus avoiding the difficulty of tracking two independent oscillators; (3) a balanced magic-T mixer which considerably reduces the noise output; (4) a double-input low-noise intermediate frequency amplifier at 30 mc; and (5) a tunable high-Q sample-carrying cavity with an almost identical cavity to balance it in the magic-T bridge. Arrangements for an oscilloscopic display of the absorption vs magnetic field and a continuous recording of the derivative of absorption vs magnetic field have been incorporated. Sensitivity of the microwave bridge system and of the spectrometer have been tested. About 1.1×10^{-1} mol of diphenyl picyl hydrazyl dissolved in purified benzene, which corresponded to approximately 1.06×10^{-14} mol of crystalline sample, has been detected by the spectrometer. (Contractor's abstract)

STA.10:003

Stanford U. Microwave Lab., Calif.

VELOCITY OF LIGHT MEASUREMENT, by E. L. Ginzton. Final rept. June 1957, 7p. incl. diagr. (ML rept. no. 400) (AFOSR-TR-57-44) (AF 18(600)1593) AD 133388 Unclassified

The possibilities were examined of improving the

STA.11:011 - STA.11:013

microwave cavity method for measuring the velocity of light. In a carefully executed experiment, the largest uncertainty arose due to the surface conditions. If the cavity surface impedance could be estimated to an accuracy of 1%, the velocity of propagation could be determined to an uncertainty of less than one part in 10^6 . In general, the measurement of the cavity Q was not sufficient to predict surface conditions. As a result, the microwave cavity method could not be considered to produce a result more accurate than 2 or 3 parts in 10^6 . In view of other possible methods, both already tried and in proposal stages, this accuracy did not seem to be sufficiently high to justify pursuing a microwave cavity experiment further. An alternate method is proposed for measuring the velocity of light employing barium titanate crystals as fast light valves.

STA.11:011

Stanford U. Microwave Lab., Calif.

A GENERAL THEORY OF KLYSTRONS WITH ARBITRARY, EXTENDED INTERACTION FIELDS, by T. Wessel-Berg. Mar. 1957, 286p. incl. illus. refs. (ML rept. no. 376) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under N6onr-25123) AD 134852

Unclassified

A general theory of the bunching of an electron beam in arbitrary longitudinal fields is established which can be applied to multicavity klystrons without restricting the number of cavities, the shape of the RF gap field, or the length of the interaction gaps. The theory is applied to klystrons with periodic (sinusoidal) gap fields. A kinematic approach (where the motion of each electron is followed along its path) and a space-charge wave theory (based on the concept of continuous space-charge flow) are used to analyze the bunching of the beam in arbitrary RF fields. The kinematic theory, a large signal approach, is valid only for zero space charge. The space-charge wave theory, a small signal approach, holds for arbitrary space charge. Both give identical results in the region of overlapping validity (where signals are small and space charge is negligible). The general interaction theories are used to analyze single-cavity oscillators or monotrons with arbitrary, extended interaction gaps. A general theory is given which permits a unified treatment of all monotron oscillators. An oscillator which uses a resonant slow-wave structure is analyzed.

STA.11:012

Stanford U. Microwave Lab., Calif.

A TRAVELING-WAVE FREQUENCY MULTIPLIER, by D. J. Bates. Apr. 1957, 107p. incl. illus. tables. (ML rept. no. 381) (In cooperation with General Electric

Microwave Lab. under AF 33(600)27784) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under N6onr-25123) AD 130433

Unclassified

Also published in Proc. Inst. Radio Engineers, v. 45: 938-944, July 1957.

An investigation was conducted on a harmonic generator which utilizes traveling-wave circuits. An expression for the harmonic current and velocity in an electron beam modulated by a traveling electric field was derived which indicates that a high harmonic current content in the beam of a traveling-wave amplifier can be expected. A frequency multiplier employing 2 forward-wave single helices in cascade was selected as the most suitable for experimental study. A dispersive helix was chosen for the output section to permit selective amplification of a particular harmonic of the input frequency; a broadband helix was chosen for the input section. An experimental traveling-wave frequency multiplier, which has an output power level on the order of 10 mw, was built and tested. The input section utilizes a nondispersive helix normally operating from 0.5 to 1.0 kmc, while the output section uses a dispersive voltage-tunable helix covering a frequency range from 2.0 to 4.0 kmc. The input section had a useful frequency range from 0.1 to 1.0 kmc. Multiplication ratios up to 10 or 15 are feasible with substantial gain and with an output power corresponding to the normal operation of the second helix as an amplifier. By using an input frequency as low as 0.1 kmc, well below the design value, harmonic output on the order of tens of milliwatts was obtained at harmonics as high as the fortieth. For a beam power of 2 to 4 and input frequencies down to 0.25 kmc, the harmonic power varied between 20 and 100 mw, depending upon the input frequency and multiplication ratios.

STA.11:013

Stanford U. Microwave Lab., Calif.

A MEGAWATT SPACE-HARMONIC TRAVELING-WAVE TUBE, by S. P. Otsuka and R. H. Pantell. May 1957, 49p. incl. illus. refs. (ML rept. no. 329) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under N6onr-25123) AD 144460

Unclassified

The tube described in this report has a pulsed output power of one megawatt with 9.6% bandwidth, where bandwidth is defined as the 3 db points for saturation power. Saturation gain is about 20 db, which is 6 db below the low-level gain. The tube is a space-harmonic S-band structure, designed to operate at a beam voltage of 100 kv and perveance 2×10^{-6} . Field configurations for the lowest and next higher passbands are drawn, based upon a field analysis and cold-test measurements. The impedance determined by perturbation measurements is compared to the impedance for the forced

AIR FORCE SCIENTIFIC RESEARCH

STA.11:014 - STA.11:017

sinusoid inside a closed region and it is found that the tube has about four times the minimum energy necessary to obtain the same bandwidth. (Contractor's abstract)

STA.11:014

Stanford U. Microwave Lab., Calif.

NOTE ON POSITIVE-ION EFFECTS IN PULSED ELECTRON BEAMS, by J. T. Senise. [Nov. 1957] [3]p. incl. diagrs. [ML rept. no. 454] (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under N6onr-25123)

Unclassified

Also published in Jour. Chem. Phys., v. 29: 839-841, May 1958.

Positive-ion effects have been observed in pulsed electron beams of short duration (0.5 to 5 microseconds), under conditions of operation normally encountered in high-power microwave tubes. Three different aspects of ion effects were studied; (1) beam focusing, (2) ion oscillations, and (3) ion trapping at scallop minima. Experimental results are given and correlated with previous work on ion effects by other authors. (Contractor's abstract)

STA.11:015

Stanford U. Microwave Lab., Calif.

A STUDY OF THE GENERATION OF SUB-MILLIMETER RADIATION BY HIGH-ENERGY ELECTRONS IN WAVE-GUIDE, by R. N. Whitehurst. Jan. 1958. 81p. incl. illus. tables, refs. (ML rept. no. 443) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research) under N6onr-25123) AD 153162

Unclassified

A theoretical treatment of the radiation from a bunched high-energy electron beam in rectangular waveguide, with particular application to the "undulator" of Motz, is presented. The development of a linear accelerator for the production of the beam is described. Experimental results from the accelerator and from the undulator are given. The theory predicts a number of discrete frequencies for each waveguide mode. The wavelengths for a beam energy of 1.6 mev are of the order of a few tenths of a millimeter. Wavelengths of a few millimeters to a tenth of a millimeter were measured. Some radiation, the origin of which is in doubt, was generated without the undulator magnetic field. A comparison of theoretical and experimental results is made. (Contractor's abstract)

STA.11:016

Stanford U. [Microwave Lab.] Calif.

SPACE CHARGE BALANCED HOLLOW BEAM WITH UNIFORM CHARGE DISTRIBUTION, by M. Chodorow and C. Susskind. [1958] (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under N6onr-25123)

Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 497-498, Feb. 1958.

The case of a stable hollow electron beam is considered when electrons have radial components of velocity. With a uniform charge density it is shown that an electron oscillates about its radial position with a wavelength about half the plasma wavelength. The variation of this wavelength with radial position is slow, so that in a few plasma wavelengths very little crossing of trajectories will occur.

STA.11:017

Stanford U. Microwave Lab., Calif.

HARMONIC GENERATION AT MICROWAVE FREQUENCIES USING FIELD-EMISSION CATHODES, by J. R. Fontana and H. J. Shaw. [1958] [2]p. incl. diagrs. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [N6onr-25123])

Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 1424-1425, July 1958.

An analysis is presented of harmonic amplitudes in terms of the emission properties of the cathodes and the operating conditions. It is shown that the analytical difficulties presented by the peculiar form of the current-voltage relationship and by the nature of the parameters controlling the operation can be solved by the use of approximations valid under practical operating conditions. The result is an equation for the harmonic amplitudes in the emission current from a field emitter subjected to rf modulation, from which the effects of the various parameters may be seen directly, and which may be used directly to calculate the performance of any field emitter for which the basic parameters are known. As a check, values calculated from this equation have been found to be consistent with values calculated by Dyke, obtained by numerical Fourier analysis of the known emission curve of a particular field emitter.

STA.11:018 - STA.11:020

STA.11:018

Stanford U. Microwave Lab., Calif.

THE INFLUENCE OF ELECTRON BEAM BEHAVIOR ON KLYSTRON EFFICIENCY, by J. R. Senise. Oct. 1958, 91p. incl. illus. refs. (ML rept. no. 552) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under N6onr-25123) AD 208425. Unclassified

This investigation aims, through direct experiment, at a better understanding of the behavior or velocity-modulated electron beams, with emphasis on those factors which influence klystron efficiency. The conditions of operation are those which are usually not covered by any theory but which are typically encountered in high-power klystron amplifiers. The experiments were performed with an rf beam analyzer. The analyzer is essentially a pulse-operated, magnetically-focused, S-band two-cavity klystron amplifier, with shielded gun, designed on the basis of actual tube practice. The device differs from a conventional klystron in that it has a continuously variable drift length and a beam-scanning arrangement which permit complete cross sections of the beam to be obtained; these show both the dc and the rf radial current density distributions at any given drift distance. From the data presented it seems to be generally true that at high signal levels the best beam is not necessarily the one of highest rf content but rather is the beam that is best able to transfer its rf content to the output load.

STA.11:019

Stanford U. Microwave Lab., Calif.

CURRENT DISTRIBUTION IN MODULATED MAGNETICALLY FOCUSED ELECTRON BEAMS, by M. Chodorow, H. J. Shaw, and D. K. Winslow. [1958] [9]p. incl. illus. diags. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [N6onr-25123]) Unclassified

Published in Jour. Appl. Phys., v. 29: 1525-1533, Nov. 1958.

Detailed measurements have been made of the dc and rf current distribution in a modulated, magnetically focused electron beam having normalized parameters in the range of values appropriate for practical medium-power and high-power klystrons. The ratio of the total rf current to the total dc current in the beam as a function of drift distance was determined experimentally under Brillouin-flow conditions for selected values of α (the ratio of the rf voltage at the input gap to the dc beam voltage). These experimental values are compared with the results predicted theoretically. Similar experimental results are presented for higher focusing fields. Detailed radial distributions of the dc and rf current were experimentally determined by using an

Iris (a plate with a small hole) to allow only a small portion of the beam to be selected at any radial position. These measurements were made at various values of α and drift distance. The results for small values of α show, as predicted by theoretical considerations for a modulated Brillouin-flow beam, that the radial rf current distribution in the beam is the same as that of a beam whose modulation is represented as sinusoidal scallops on a beam of constant (volume) charge density. As either α or the focusing field, or both, are increased, the rf current is no longer confined to the beam periphery but becomes more evenly distributed throughout the beam cross section. (Contractor's abstract)

STA.11:020

Stanford U. Microwave Lab., Calif.

KINEMATICS OF GROWING WAVES, by P. A. Sturrock. [1958] [16]p. incl. diags. refs. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [N6onr-25123]) Unclassified

Published in Phys. Rev., v. 112: 1488-1503, Dec. 1, 1958.

This paper is concerned with the problem of distinguishing between amplifying and evanescent waves. These have, in the past, been distinguished by considerations of energy transfer or of the initial and boundary conditions with which a wave must be associated. Both procedures are open to criticism. The problem is here interpreted kinematically: we investigate the classes of wave functions which a given propagating system may support, without inquiring into the way these disturbances may be set up, and postponing inquiry into the boundary conditions necessary. In this way, we may distinguish between amplifying and evanescent waves by determining whether a wave function which may be analyzed into "real-frequency" waves may also be analyzed into "real-wave-number" waves. This question may be answered by means of a certain diagram, which may be constructed from knowledge of the dispersion relation. Interchange of the roles of time and space leads to the statement and solution of a further problem. If a propagating system is unstable, the instability may be such that a disturbance grows, but is propagated away from the point of origin: this is termed "convective instability." On the other hand, the instability may be such that the disturbance grows in amplitude and in extent, but always embraces the original point of origin: this is termed "nonconvective instability." The statement that the system supports amplifying waves is synonymous with the statement that the system exhibits convective instability. A system which exhibits nonconvective instability may not be used as an oscillator. It is possible to distinguish between convective and nonconvective instability by a further diagram which also may be constructed from knowledge of the dispersion relation. Our theory enables us to make the following assertions. If ω is real for all real k , then any complex k , for real ω , denotes an evanescent wave.

STA.19:001; STA.20:001, 002

Conversely, if k is real for all real ω , then any complex ω , for real k , denotes nonconvective instability. The theory is illustrated by certain simple examples and by discussion of the result of weak coupling between certain types of waves.

STA.19:001

Stanford U. Microwave Lab., Calif.

PLASMA RESEARCH AT STANFORD UNIVERSITY (Abstract), by M. Chodorow and G. S. Kino. [1958] [2]p. (Bound with its AFOSR-TR-58-125; AD 162274) (AF 49- (838)415) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The study has as its aims (1) the investigation of the use of microwaves for diagnosing the properties of a plasma and (2) the investigation of the possibility of generating or amplifying microwave signals in devices which use a plasma column as the propagating circuit. An experiment to investigate the amplification of microwave signals along an electron beam passing through a plasma is being carried out. The plasma, in this case, is the positive column of a DC Hg vapor gas discharge at a pressure of the order of 10^{-3} mm. The electron beam passes along a straight section of the column parallel to its axis. The possible electromagnetic modes of the system have been investigated theoretically and it has been shown that RF fields growing exponentially in the direction of travel of the beam may be set up. There are 2 possible amplifying modes both of which give gain which is sharply peaked at the plasma frequency in the neighborhood of the beam. Consequently by making the electron gun movable it is possible to determine the charge density variation over the cross section of the plasma column. An experimental determination of microwave propagation along a plasma column is also being carried out. It has been shown theoretically and experimentally by Trivelpiece and Chorney that slow TM waves propagate along a uniform plasma column at frequencies below the plasma frequency. The theory has been extended by a variational method to be able to predict the propagation characteristics for a plasma which is not uniform over its cross section, making it possible to carry out an independent check of the charge density measurement made in the electron beam experiment.

STA.20:001

Stanford U. Radio Propagation Lab., Calif.

RESTORATION IN THE PRESENCE OF ERRORS, by R. N. Bracewell. Oct. 3, 1957, 6p. incl. diagrs. table,

refs. (AFOSR-TN-57-533) (Bound with its AFOSR-TN-57-534; AD 136520) (AF 18(603)53) AD 136519 Unclassified

Also published in Proc. Inst. Radio Engineers, v. 46: 106-111, Jan. 1958.

The observed antenna temperature due to a celestial source distribution differs from the true distribution in being smoother; various methods are known for operating on the observed distribution to gain better agreement with the true distribution. Current practice includes restoration by successive substitutions, by the chord construction, etc., but also shows a trend towards complete omission of any restoration, which is, no doubt, partly due to awareness that the true distribution is not fully determined by the observations. The isolation of a principal solution has, however, removed uncertainty as to the significance of nonuniqueness. The remaining question as to the degree of restoration which can be tolerated is solved here in terms of statistical properties of the errors. The solution shows that any proposed method of restoration must include mention of the character of the true distribution and of the errors; otherwise cases could be constructed where the proposed method led to deterioration. In the simplest case of independent random errors and a poorly resolved distribution, the rms level of the errors relative to the observed temperature is the relevant parameter; e.g., with a random error level as great as 15%, agreement with the true distribution improves up to the third stage of restoration by successive substitutions or on application of the chord construction. (Contractor's abstract)

STA.20:002

Stanford U. Radio Propagation Lab., Calif.

RADIO INTERFEROMETRY OF DISCRETE SOURCES, by R. N. Bracewell. Oct. 3, 1957, 9p. incl. diagrs. refs. (AFOSR-TN-57-534) (Bound with its AFOSR-TN-57-533; AD 136519) (AF 18(603)53) AD 136520 Unclassified

Also published in Proc. Inst. Radio Engineers, v. 46: 97-105, Jan. 1958.

Salient features of the theory and practice of radio interferometry are presented with special attention to assumptions and to the specifically two-dimensional aspects of the subject. The measurable quantity on an interferometer record is defined as complex visibility by generalization from an analogous quantity in optical interferometry. Subject to conditions on antenna size and symmetry, the observed complex visibility is equal to the normalized two-dimensional Fourier transform of the source distribution, with respect to certain variables S_x and S_y which are defined. This transform is in turn identically equal to the complex degree of coherence Γ between the field phasors at the points occupied by the interferometer elements. The correlation between the

instantaneous fields, and that between the instantaneous intensities are less general parameters which are, however, deducible from T. A theorem is proved according to which only certain discrete stations on a rectangular lattice need be occupied for full determination of a discrete source distribution. Procedures in interferometry are discussed in the light of this result, and an optimum procedure is deduced. Current practice is considered over-conservative, e.g., independent data in the case of the sun are obtainable only at station spacings of about 100 wavelengths on the ground, a fact which has not hitherto been taken into account. (Contractor's abstract)

STA.20:003

Stanford U. [Radio Propagation Lab.] Calif.

ANTENNA PROBLEMS IN RADIO ASTRONOMY, by
R. N. Bracewell. [1957] [4]p. (AF 18(603)53)
Unclassified

Presented at I. R. E. National Convention, New York,
Mar. 18-21, 1957.

Published in I. R. E. National Convention Record, Pt. 1:
68-71, 1957.

A large antenna is under construction at Stanford U. for the purpose of obtaining pictures of the sun showing the distribution of radio brightness at a wavelength of 10 cm. This paper discusses some of the design problems, not from the narrow viewpoint of designing to specifications but from the overall system viewpoint in which, to some extent, the specifications are an end product of the design, not a starting point.

STA.06:013

Stanford U. [Stanford Electronics Labs.] Calif.

THE COMMUNICATION POSSIBILITIES OF A NEW
TYPE OF IONOSPHERIC SCATTER (Abstract), by A.
M. Peterson, O. G. Villard, Jr. and others. [1957] [1]p.
(Sponsored jointly by Office of Naval Research, Signal
Corps, and Air Force Office of Scientific Research
under [Nonr-22524])
Unclassified

Presented at IRE-URSI Symposium, Washington, D. C.,
Apr. 30-May 3, 1956.

Published in I.R.E. Trans. of Professional Group on
Antennas and Propagation, v. AP-5: 154, Jan. 1957.

A new class of radio echoes from the ionosphere has recently been identified at Stanford U. These echoes originate within the E and F layers, under conditions where the line of sight from a radar meets a line of the earth's magnetic field at perpendicular incidence. This appears to be the first direct evidence of a potentially

useful ionospheric scatter occurring at F layer height. The echoes are seen primarily at night, and are readily detectable with low power radars operating in the 6 to 30 mc frequency range. They are observable for several hr at a time on a large percentage of the nights. Although their exact cause is unknown, it is reasonable to suppose that they are a manifestation of low-latitude, low-intensity auroral activity in view of their night-time occurrence, and their aspect-sensitivity with respect to the earth's magnetic field. On the other hand they have been seen regularly as far south as New Mexico and are not directly associated with geomagnetic disturbances. The field-aligned ionization may be used for communication purposes in much the same manner as auroral ionization, that is, by pointing the antennas at both locations wishing to communicate, generally towards the north. The geometry of reflection from the field aligned ionization is investigated, outlining the area of "useful" ionization and the "region of communication" for both the E and F layer heights of reflection. The probability of obtaining communication from a transmitter located at Stanford to a receiver at any location within the region of communication is determined.

STA.06:014

Stanford U. [Stanford Electronics Labs.] Calif.

EVIDENCE OF A RELATIONSHIP BETWEEN BACK-
SCATTER FROM FIELD-ALIGNED IONIZATION IN THE
F-LAYER, AND FLUCTUATIONS IN THE 5577A [OI]
AIRGLOW (Abstract), by O. G. Villard, Jr. and S. Stein.
[1957] [1]p. (Sponsored jointly by Office of Naval Re-
search, Signal Corps, and Air Force [Office of Scientific
Research] under [Nonr-22524])
Unclassified

Presented at IRE-URSI Symposium, Washington, D. C.,
Apr. 30-May 3, 1956.

Published in I.R.E. Trans. of Professional Group on
Antennas and Propagation, v. AP-5: 157, Jan. 1957.

It has been found that radar echoes may be obtained from ionization lying within the E and F layers of the ionosphere, and behaving as if it consisted of scattering columns aligned with the earth's magnetic field. The echoes, while generally strongest in the hours around midnight, fluctuate considerably in intensity from time-to-time and from night-to-night. The strongest reflection is obtained when the line-of-sight from a transmitter meets a field line at perpendicular incidence at an altitude roughly corresponding to the ion density maxima of the E and F layers. Although this requirement restricts considerably the area from which echoes may be received at any given geographical location, it is nevertheless possible—in the case of the F-layer—to determine whether activity exists within a sector of roughly ± 30 degrees centered on geomagnetic north. This sector is considerably wider in the case of E-layer echoes. In an effort to determine whether a relationship exists between these echoes and fluctuations in

STA.06:015 - STA.06:017

the 5577A [OI] airglow, a scatter-sounder has been operated at the Upper Air Research Observatory, Sacramento Peak, New Mexico, in conjunction with the light measurements of E. A. Manring and H. B. Pettit. Several nights, during which simultaneous records were made, have been examined in detail. A reasonable agreement between F-layer radio echoes and light fluctuations was found, suggesting a strong connection between the two effects. Certain of the diurnal features of the green airglow emission and the F-region backscatter were found to be similar.

STA.06:015

Stanford U. [Stanford Electronics Labs.] Calif.

THE FORMATION OF SPORADIC E IONIZATION AND THE RECENTLY DISCOVERED LOW LATITUDE ASPECT SENSITIVE IONIZATION ALIGNED WITH THE EARTH'S MAGNETIC FIELD LINES (Abstract), by R. L. Leadabrand, A. M. Peterson, and O. G. Villard, Jr. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [Nonr-22524]) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., Apr. 30-May 3, 1956.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-5: 156, Jan. 1957.

Radio echoes due to reflection from aspect sensitive ionization aligned with the earth's magnetic field lines are consistently observed at Stanford U. The echoes corresponding to oblique reflection from the E- and F-regions of the ionosphere, have many characteristics similar to auroral echoes, although their occurrence is not associated with magnetic disturbances. The appearance of the E-region aspect sensitive, oblique echoes, has been found to be correlated with the appearance of night time sporadic-E ionization at middle latitudes. The nature of the field aligned ionizations is such that it suggests a production mechanism of charged particle bombardment, thus offering a possible explanation for the production of night time sporadic-E ionization.

STA.06:016

Stanford U. [Stanford Electronics Labs.] Calif.

ON THE INTERPRETATION OF LONG-RANGE RADIO ECHOES FROM AURORAL IONIZATION (Abstract), by S. Stein, and O. G. Villard, Jr. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [Nonr-22524]) Unclassified

Presented at IRE-URSI Symposium, Berkeley, Calif., Oct. 11-12, 1956.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-5: 166, Jan. 1957.

Ever since the inception of continuous scatter-sounder recordings at Stanford U., long-range radio echoes from the auroral zone have been detected. These long-range echoes are attributable to reflections from ionization associated with the aurora. Long-range propagation paths from Stanford into the auroral zone via the E layer and F layer were investigated to determine the loci of perpendicular intersection between the ray paths and the terrestrial magnetic field lines. Range histograms for auroral-zone echoes were obtained for the different radio frequencies of operation. Comparisons were made between the experimental histograms and the ranges predicted by the propagation modes that occur at each frequency, in order to determine the altitudes of reflection. Through analysis of scatter-sounder PPI recordings of individual long-range auroral-zone echoes, the propagation mode can frequently be deduced. The altitude of perpendicular intersection of the ray path with the magnetic field at the range of the auroral-zone echo was determined for many cases. A conclusion from this study is: long-range auroral-zone echoes result from long-range propagation into the auroral region with reflection from ionization situated at E-region heights. This result is in accord with the investigations of auroral echoes performed by other experimenters at high latitudes.

STA.06:017

Stanford U. [Stanford Electronics Labs.] Calif.

SOME CHARACTERISTICS OF EQUATORIAL F-REGION SCATTERING DEDUCED FROM SOUNDINGS MADE ABOARD A MOVING SHIP (Abstract), by O. G. Villard, Jr. and P. B. Gallagher. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [Nonr-22524]) Unclassified

Presented at IRE-URSI Symposium, Berkeley, Calif., Oct. 11-12, 1956.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-5: 166, Jan. 1957.

A 17-mc scatter-sounder was operated aboard a military transport vessel during a voyage from California to the Marshall Islands (geomagnetic latitude approximately 3° north) and return, Mar. 5-30, 1956. The equipment had a peak power output of one kilowatt and a pulse length variable from 200 to 2000 μ sec. A beam antenna was used, consisting of a three-element Yagi rotatable in azimuth and capable of being tilted so as to direct its major lobe upwards as well as along the horizon. During the evening hr, at geomagnetic latitudes less than 15°, a strong echo was obtained from ionization believed to be the F-region scatter observed by Booker and Wells at Huancayo, Peru, and first reported in 1938. The echo was present at times when the f_oF_2 was as

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low as 11 or 12-mc. The measurements suggest (1) that the ionization is not, in general, field-aligned; (2) that it is in the form of a horizontal layer; and (3) that its time of appearance is a function of the geomagnetic latitude of the observing station.

STA.06:018

Stanford U. Stanford Electronics Labs., Calif.

INTERACTION-IMPEDANCE MEASUREMENTS BY PERTURBATION OF TRAVELING WAVES, by R. P. Lagerstrom. Feb. 11, 1957, 131p. Incl. diagrs. tables, refs. (Technical rept. no. 7) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-22524) AD 122989 Unclassified

Three methods of perturbing traveling waves on periodic slow-wave structures are analyzed as techniques for evaluating the interaction impedance of structures suitable for traveling-wave tube and backward-wave oscillator operation. A perturbation integral relating the fields at a material perturbation to a resulting change in the propagation constant of a single mode is derived. The integral is almost identical to Kino's normal-mode perturbation expression assuming a small change in propagation constant. A dielectric-rod perturbation placed in a non- θ -varying field is analyzed without the usual assumption that the field be uniform or that the radius or dielectric constant be small. Thus, correction factors for rods of finite size are obtained, and the effective dielectric constant is compared with conducting-rod perturbations which have been analyzed by Kino. The latter are found to give more perturbation for a given radius, but the dielectric rod can afford appreciably more selection of the TM fields over the TE portion of the wave. Curves and formulae are given for evaluating impedance from measured data of both perturbed standing waves (on a resonated structure) and traveling waves. A longitudinal string of conducting needles, spaced with the same period as the structure, is proposed for separating θ - and z -varying space harmonics by virtue of their essential orthogonality in these two coordinates. A perturbation formula is presented, with examples of the anticipated simple space pattern obtained by moving the needles in both the θ - and z -coordinates in the fields of a single traveling wave. A Fourier integration is not required to separate the dominant harmonics. The presence of more than one space harmonic should be easily detected as a sinusoidal departure from a constant perturbation. A small stretchable helix is also proposed, with a qualitative discussion of the nature of its effect, as a velocity sensitive perturbation resembling an electron beam. Experimental methods and sources of error are discussed. Experimental data obtained with dielectric- and metallic-rod perturbations of a tape helix are found to be in close agreement with the beam-measured data of Watkins and Siegman for essentially the same helix. The variation of the correction factors with dielectric

constant and radius is found to be self-consistent, and is related accurately to the metallic-rod measurements when the TE fields are accounted for.

STA.06:019

Stanford U. Stanford Electronics Labs., Calif.

GROWING WAVES IN ELECTRON STREAMS IN CROSSED ELECTRIC AND MAGNETIC FIELDS, by H. Heffner and T. Unotoro. Feb. 25, 1957, 20p. (Technical rept. no. 14) (Sponsored jointly by Office of Naval Research, Signal Corps, and [Air Force Office of Scientific Research] under Nonr-22524) AD 124276 Unclassified

The problem of the diocotron effect or growing wave effect present in drifting beams under crossed-field conditions is analyzed. It is assumed that the beam is thin and travels between two parallel conducting planes. It is shown that a growing wave exists due to simple space-charge forces. The rate of growth under idealized conditions is determined and the nature of this and of the other propagating waves is examined. (Contractor's abstract)

STA.06:020

Stanford U. [Stanford Electronics Lab.] Calif.

NEW EVIDENCE OF ANOMALOUS TRANSEQUATORIAL IONOSPHERIC PROPAGATION, by O. G. Villard, Jr., S. Stein, and K. C. Yeh. [1957] 12p. incl. illus. diagrs. refs. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-22524) Unclassified

Presented at I.R.E. National Convention, New York, Mar. 18-21, 1957.

Published in I.R.E. National Convention Record, Pt. 1: 19-20, 1957.

Echoes of exceptionally long delay detected by a H. F. radar located in the West Indies are interpreted as ground backscatter propagated by two successive reflections from the F-region of the ionosphere, without intermediate ground reflection. Propagation of this sort between two points on the earth requires an initial ionospheric tilt followed by one of opposite sign. Tilts of the required sort take place regularly in equatorial regions as a consequence of two daily bulges in the ionosphere, one occurring at approximately 1900 local time over the geomagnetic equator, and the other occurring around noon in the vicinity of the sub-solar point. It is shown that tilt-supported propagation can take place at frequencies considerably in excess of the MUF predicted in the usual way. It is believed that these results may explain the reports by radio amateurs of anomalous propagation between North and South America.

STA.06:021 - STA.06:024

STA.06:021

Stanford U. Stanford Electronics Labs., Calif.

MICROWAVE NOISE FLUCTUATIONS IN THE POTENTIAL MINIMUM REGION OF AN ELECTRON BEAM, by A. E. Siegman. Apr. 22, 1957, 252p. incl. diagrs. illus. tables, refs. (Technical rept. no. 401-1) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22525 and Nonr-22524) AD 128995

Unclassified

An understanding of these noise fluctuations is basic to the analysis and design of low-noise beam-type microwave amplifiers. Related topics discussed are: (1) the frequency spectrum of the noise current fluctuations at the minimum plane, (2) the behavior of noise fluctuations in the region immediately beyond the minimum (contrary to previous assumption, results show that Haus's noise parameters S and II vary significantly with distance between $\eta = 0$ and $\eta = 4$), (3) an unsuccessful attempt to measure noise current inside the accelerating region of an electron gun by using a large-scale low-frequency model diode, and (4) an Llewellyn-equation analysis of the effects of an r-f impedance shunting a diode.

STA.06:022

Stanford U. Stanford Electronics Labs., Calif.

SOME PROPERTIES OF FILTER HELICES FOR TRAVELING-WAVE TUBES, by C. T. Sah and G. A. Loew. May 15, 1957, 49p. incl. diagrs. (Technical rept. no. 15) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 132240

Unclassified

A study was conducted on longitudinal and transverse capacitively loaded sheath helix circuits. The approach is primarily based on a matrix analysis of linear networks and is designed for application to the external circuit TWT interaction geometry. The results obtained may be used for approximations of other types of lumped-distributed circuits. The interaction structure assumed is uniformly periodic. From the viewpoint of dispersion, the transversely loaded helix appeared to be the better circuit for forward-wave amplifier operation. The impedance in the forward mode was smaller than that for the longitudinal mode. This deficiency could be overcome by combining the advantages of the 2 types of loading: the circuit could be loaded both transversely and longitudinally with the gaps in the longitudinal arms. The transversely loaded helix with high impedance properties was recommended for backward wave oscillator operations.

STA.06:023

Stanford U. Stanford Electronics Labs., Calif.

SPACE CHARGE WAVES IN HARRIS-FLOW BEAMS, by H. C. Hsieh. June 6, 1957, 55p. incl. diagrs. table, refs. (Technical rept. no. 16) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 134943

Unclassified

The investigation of space-charge waves in Harris-flow beams was made under the usual assumptions of small signals and non-relativistic velocities. Emphasis was on slow TM waves propagating on an axially symmetric hollow cylindrical beam focused by a radial d-c electric field. Starting with Maxwell's equations and with aid of the equation of motion, the continuity equation, and the definition of current density, the field equations for the regions both inside and outside of the beam were found. A perturbation technique was applied to the steady-state-flow beam in obtaining the wave equation for the beam region; due to the radial component of electron motion, the beam surface is rippled. The rippled beam was replaced by a uniform cylindrical beam with an a-c surface current density. Upon applying appropriate boundary conditions, the determinantal equation was obtained. From this determinantal equation the plasma-frequency reduction factor was derived. To obtain the impedance reduction factor, an ideally thin beam was established and the thin-beam theory was employed. Thus the expressions both for the plasma-frequency reduction factor and for the impedance reduction factor have been derived and the curves showing these factors as a function of the product of beam thickness and wave propagation constant were plotted. (Contractor's abstract)

STA.06:024

Stanford U. Stanford Electronics Labs., Calif.

ON THE PROPERTIES OF MATCHED FILTERS, by D. W. Lytle. June 10, 1957, 182p. incl. diagrs. tables, refs. (Technical rept. no. 17) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 138007

Unclassified

Matched filters are defined. Their properties as optimum signal detectors are discussed, and conditions are enumerated under which matched filters are realizable. The synthesis procedure employing tapped delay lines allows the greatest adaptability. Matched filters are advantageously used in systems in which the transmitted signal may be specified by the system designer. The quality of input and output signal shapes is measured quantitatively by the effective bandwidth W_e and the effective time duration T_e . Binary matched signals offer good W_e and T_e . Two novel methods of synthesizing

STA.06:025 - STA.06:027

matched filters, namely multiple band-pass and all-pass inverse-matched filters, are investigated. Both appear to be inferior to tapped-delay-line matched filters. (Contractor's abstract, modified)

STA.06:025

Stanford U. [Stanford Electronics Labs.] Calif.

EFFECTS OF IONOSPHERIC LAYER TILTS ON HIGH-FREQUENCY RADIO PROPAGATION (Abstract), by S. Stein. [1957] [1]p. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under [Nonr-22524]) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 22-25, 1957.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-5: 330-331, July 1957.

The F layer, as is well known, has a complex global distribution of ion density. In addition to the conventional ionospheric parameters, the F layer may be further characterized by an equivalent layer tilt, a function of frequency and takeoff angle. Low angle rays reflected from a tilted F layer may propagate beyond the bulge of the earth, without striking the ground, and illuminate the ionosphere again. When sufficient ion density exists at the second illuminated region, the rays will propagate on around the earth. A ray may be reflected several times before striking a properly oriented tilt so that the surface of the earth is illuminated. These modes are called n_F modes, where n is the number of layer reflections.

The theory of tilt supported modes has been successfully applied to the anomalous propagation across the equator. Theoretical Chapman layers and other models are investigated to find the ray trajectories and determine equivalent layer tilts. These results form the nucleus of a prediction scheme for tilt supported modes. The characteristics of multiple-hop ground backscatter were

investigated in order to assist in recognition of n_F mode

ground scatter. Detection of n_F mode ground scatter occurs as a consequence of geometrical time-delay focusing and to a lateral beam effect. Under some conditions Peterson's "minimum-time-delay" focusing is also considered. Comparisons are made between calculations and experimental backscatter records obtained at the location of Stanford U. Tilt supported rays may propagate long distances without the necessity of ground reflections and without reentering the absorbing D region except on the last leg where the earth's surface is illuminated. The radio frequency of n_F mode propagation is examined in comparison with the conventional muf.

STA.06:026

Stanford U. Stanford Electronics Labs., Calif.

POTENTIAL-MINIMUM NOISE IN THE MICROWAVE DIODE, by A. E. Siegman and D. A. Watkins. July 2, 1957 [5]p. incl. diagrs. refs. (Technical rept. no. 19) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 136032 Unclassified

Also published in I.R.E. Trans. of the Professional Group on Electron Devices, v. ED-4: 82-86, Jan. 1957.

An analysis of the potential-minimum region in the microwave diode is presented which predicts the amount of noise convection current at the potential minimum under conditions present in guns of low-noise traveling-wave tubes and klystrons. Contrary to previous work by one of the authors, this analysis partially includes the effects of finite transit angle between the cathode and potential minimum. The results indicate that under certain conditions of space-charge limitation, the noise convection current may be larger than full shot noise, whereas under other conditions reduction by as much as a factor of four may be obtained. When the results of this work are applied to the noise-figure theory of traveling-wave tubes and klystrons, it is found that their minimum obtainable noise figure may be in the vicinity of 4 db rather than the previously predicted 6 db with reasonable cathode current densities. For very large current densities or low operating frequencies, the present theory indicates that there is no theoretical limit to the minimum noise figure of such devices, in agreement with the previous work. (Contractor's abstract)

STA.06:027

Stanford U. Stanford Electronics Labs., Calif.

ON THE USE OF DELAY LINES AS NETWORK ELEMENTS, by L. E. Franks. July 29, 1957, 126p. incl. diagrs. refs. (Technical rept. no. 18) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 138790 Unclassified

This study concerns the development of analysis and synthesis techniques for networks containing idealized distributed-constant elements in addition to the usual set of lumped-constant elements having parameters R , L , and C . The idealized distributed element is taken to be a lossless delay line represented by the parameters R_0 and T_0 . R_0 is the characteristic resistance and T_0 is the electrical length in terms of the time delay between terminal pairs of the delay-line element. Networks consisting of delay lines and lumped elements are called line-lumped networks. Analysis procedures are directed toward finding transfer functions for a network containing an arbitrary interconnection of delay lines and lumped

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elements. Some matrix methods for finding these transfer functions are presented. The transfer functions are not rational in the complex frequency variable and the usual procedures for transient analysis are not applicable. A method for transient analysis based on the time-series representation is presented. A particularly useful form of the time-series representation is the z-transform, a familiar mathematical tool for the analysis of sampled-data systems. An examination of the time-domain and frequency-domain response properties of line-lumped networks reveals some characteristics remarkably different from the responses of lumped-element networks. These characteristics are used to advantage in the development of synthesis procedures for approximating a prescribed impulse response by z-transform methods. The z-transform methods are particularly applicable to numerically prescribed data. Special emphasis is given to synthesis of networks having impulse responses of limited time duration. (Contractor's abstract)

STA.06:028

Stanford U. Stanford Electronics Labs., Calif.

THE INITIAL RADIUS OF METEORIC IONIZATION TRAILS, by L. A. Manning. Aug. 20, 1957, 27p. incl. diagrs. tables. (Technical rept. no. 22) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 143608 Unclassified

Also published in Jour. Geophys. Research, v. 63: 181, Mar. 1958.

The formation about the path of a meteor of regions of ionized and neutral atoms of meteoric material is investigated from the viewpoint of kinetic theory. It is found that the high initial velocity of the diffusing particles causes the trail to quickly reach an "initial radius" from which normal diffusion then proceeds. It is shown that the reflected signal may for most purposes be computed on the assumption that the trail reaches this initial radius instantaneously. The value of the initial radius is approximately 14 mean-free-paths; it is thus greater for the neutral than for the ionized trail. It is shown that at very high frequencies the initial radius may reduce the amplitude of the returned signal from under-dense trails by as much as 50 db. If heating is neglected, it is shown that the effect of initial radius on over-dense trails is marked at the same heights and frequencies as for under-dense trails. (Contractor's abstract)

STA.06:029

Stanford U. Stanford Electronics Labs., Calif.

THE ROLE OF IONOSPHERIC-LAYER TILTS IN LONG RANGE HIGH-FREQUENCY RADIO PROPAGATION, by

S. Stein. Aug. 20, 1957, 91p. incl. illus. diagrs. tables, refs. (Technical rept. no. 21) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 139831 Unclassified

Long range propagation of HF and VHF radio wave propagation due to horizontal density variations in the F-layer has been studied for various multiple reflection modes. The build-up of the modes has been explained in terms of geometrical time-delay focusing. The times of occurrence, length of individual occurrence, and direction of occurrence are related to the structure of the F-layer and scattering from the top of the E-layer. Auroral reflections and radar surveillance of the auroral ionization are discussed.

STA.06:030

Stanford U. Stanford Electronics Labs., Calif.

TRANSISTOR MEASUREMENTS USING THE INDEFINITE ADMITTANCE MATRIX, by J. P. Paddock. Aug. 20, 1957, 27p. incl. illus. diagrs. tables. (Technical rept. no. 20) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 142978 Unclassified

A method is shown whereby four measurements made directly on commercial bridges may be used to find the admittance parameters of a transistor in any orientation common-base, common-emitter, or common-collector merely by taking appropriate sums of the measured quantities. Although apparently twelve short-circuit admittances are necessary to describe a transistor in all three orientations, only nine of these are unique. As shown by Shekel, the nine quantities may be arranged in a three-by-three matrix, the indefinite admittance matrix. This matrix may be completely determined if only four elements are known, since the sum of the elements in any row or column is zero. Some sets of four elements offer advantages in convenience, accuracy in measurement, and accuracy in determining the indefinite admittance matrix. The set of four elements which is superior in most circumstances is specified for junction transistors. Instruments and circuit arrangements for measuring the admittance parameters at r-f are described. (Contractor's abstract)

STA.06:031

Stanford U. Stanford Electronics Labs., Calif.

MOTION OF SPORADIC-E PATCHES DETERMINED FROM HIGH FREQUENCY BACKSCATTER RECORDS, by C. Clark. Sept. 18, 1957, 106p. incl. illus. diagrs. tables, refs. (Technical rept. no. 24) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 143606 Unclassified

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The results are presented from a study to observe average behavior of Sporadic-E, E_s , derived from a continuous 3-yr back-scatter record. The lifetime of the 2700 E_s patches observed varied from a few minutes to 10.5 hr with a mean value of 3 hr. Every patch was examined for motion, and plots of 251 cases were made. Speed and direction distributions are presented with geographic, diurnal, and seasonal occurrence information. The speed distribution is peaked at 250 km/hr with a range from less than 100 to 1000 km/hr. Motion is predominantly west. Speeds are found to agree generally with measurements of meteor trail drift and apparent ionospheric motion measured by radio fading methods. Supporting evidence of the reality of the observed motion was obtained from vertical-incidence sounding equipment. Speed and directional variation of moving patches showed small systematic annual and diurnal variations with maximum speeds occurring in summer and winter. A larger fraction of the patches moved at night and in winter. A measure of speed change with height of occurrence of the E_s patch is obtained with an average value of 19 km/hr speed increase per km increase in height. The E_s appears more patchy when viewed looking south and west from Stanford. Evidence against E_s formation and motion by thunderstorms or electromagnetic radiation is presented. E_s formation and motion is related to turbulence and winds. (Contractor's abstract)

STA.06:032

Stanford U. Stanford Electronics Labs., Calif.

A STATISTICAL STUDY OF TRANSISTOR HIGH-FREQUENCY EQUIVALENT CIRCUITS, by R. L. Walker. Sept. 20, 1957, 83p. incl. diagrs. tables, refs. (Technical rept. no. 23) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 145430 Unclassified

An experiment performed upon statistically significant numbers of transistors is described. Its purpose was to evaluate the efficacies of a number of high-frequency equivalent circuits by comparing directly for each individual transistor the numerical values of selected quadripole parameters obtained by measurement and by means of the equivalent circuits under scrutiny. For a group of 93 alloy junction Ge transistors and a group of 47 surface-barrier Ge units, the percentage of error was obtained for high-frequency values of common base G_{11} , $|Y_{12}|$, $|Y_{21}|$ and G_{22} derived from the equivalent circuit and compared with values determined by direct bridge measurement. The means, standard deviations, and form of distribution of these error percentages were studied. A simple equivalent circuit coupled with a moderately complex rational

approximation for the frequency dependence of alpha produced about 10% errors in the prediction of the 4 high-frequency factors. A simpler alpha expression resulted in 25% errors, but more sophisticated expressions offered no improvement in results. The simple equivalent circuit was established as a valuable link between transistor device parameters and the quadripole parameters. New methods were developed for the determination of the base spreading resistance, the collector depletion layer capacitance, and the alpha generator cut-off frequency.

STA.06:033

Stanford U. Stanford Electronics Labs., Calif.

ELECTRON TRAJECTORIES IN THE BACKWARD-WAVE OSCILLATOR, by J. W. Gewartowski. Oct. 29, 1957, 55p. incl. illus. diagrs. refs. (Technical rept. no. 25) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 144456 Unclassified

Results are presented of an experimental study of the spent beam of a backward-wave oscillator. The instantaneous velocity and current of the spent beam are measured using a velocity analyzer built onto the collector of a scaled 80-mc backward-wave oscillator. The tube employs a sheet beam and interdigital line, twelve ft long. It is designed to be representative of large-space-charge tubes. The measured trajectories of the spent beam are examined to deduce the mechanism of interaction between the beam and the circuit along the whole length of the tube. It is found that the level of oscillation is determined by nonlinear effects in the convection current. Finally, the mechanism of r-f output efficiency saturation at high beam currents is found to be caused by electrons which fall back in phase from a retarding to an accelerating circuit field. (Contractor's abstract)

STA.06:034

Stanford U. Stanford Electronics Labs., Calif.

THEORY OF C-W SOLID STATE MASERS, by P. N. Butcher. Dec. 15, 1957, 125p. incl. illus. refs. (Technical rept. no. 155-1) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [Nonr-22524] and DA 33-039-sc-73178) AD 150860 Unclassified

Attention was directed toward several aspects of the theory of CW solid state masers which use crystals containing paramagnetic ions as the active material. There are 6 relaxation parameters which are of prime significance. The required pump power is determined by the product of the spin-spin and spin-lattice relaxation times for the pump transition. Contribution to the cavity Q (at the signal frequency) from the paramagnetic ions is inversely proportional to the spin-spin relaxation time

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for the signal transition. The value is negative if a relaxation parameter called the pump relaxation time ratio is sufficiently great, and consequently the cavity Q is negative if the ohmic losses are sufficiently small. The large-signal characteristics of a maser are controlled by the product of the spin-spin and spin-lattice relaxation times for the signal transition and the product of the pump relaxation time ratio and a sixth relaxation parameter called the signal relaxation time ratio. Cavity maser amplifiers have a constant root-gain-fractional-bandwidth product. An analysis was made of the noise in a maser, in which the ions are treated quantum-mechanically and the electromagnetic field is treated classically. The noise parameter of a 1-port cavity maser is equal to the ratio of the modulus of the cavity Q in the presence of the paramagnetic ions to the cavity Q in the absence of the paramagnetic ions. Noise parameter of a 2-port cavity maser is always greater than that of a 1-port cavity maser with the same cavity Q in the presence of the paramagnetic ions. Energy-level diagrams for the chromium ions in cobalt-diluted potassium chromite, for various directions of the magnetic field, are given in an appendix.

STA.06:035

Stanford U. Stanford Electronics Labs., Calif.

SIMULTANEOUS ASYNCHRONOUS OSCILLATIONS IN CLASS-C OSCILLATORS, by M. I. Dismar and W. A. Edson. Oct. 7, 1957, rev. Jan. 2, 1958 [9]p. incl. diagrs. (Technical rept. no. 42) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22510 and [Nonr-22524]) AD 203097 Unclassified

Also published in Proc. Inst. Radio Engineers, v. 46: 895-903, May 1958.

Consideration is given to simultaneous asynchronous oscillations in systems having a moving reference point. The system chosen for study is a Class-C pentode oscillator. It is shown, both analytically and experimentally, that self-starting asynchronous oscillations are attainable in such a system. Transient and steady-state solutions are obtained for the Class-C oscillator containing one and two degrees of freedom. The method of analysis employed is that of equivalent linearization as described by Kryloff and Bogoluboff. The existence of asynchronous oscillations is also explained by the phenomenon of negative discrimination. (Contractor's abstract)

STA.06:036

Stanford U. [Stanford Electronics Labs.] Calif.

THE GEOMETRY OF AURORAL COMMUNICATIONS, by R. L. Leadabrand and I. [W.] Yabroff. [1958] [8]p. incl. diagrs. refs. (Sponsored jointly by Office of Naval

Research, Signal Corps, and Air Force [Office of Scientific Research] under [Nonr-22524]) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., Apr. 30-May 3, 1956.

Abstract published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-5: 154, Jan. 1957.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-6: 80-87, Jan. 1958.

As early as 1939, radio amateurs found auroral ionization useful for communication purposes. Such ionization makes hf and vhf propagation possible over paths as great as several hundred kilometers when other more normal ionospheric propagation modes do not exist. The geometry of reflection is investigated for a variety of transmitter locations based upon the assumption of specular reflection from columnar ionization aligned with the earth's magnetic field lines. The results of the investigations outline the region of useful auroral ionization and the regions on the earth within which the auroral propagation is possible. The probability has been determined of obtaining propagation from a particular transmitter location to any receiver location within the region of propagation. These geometrical studies allow the communicator to predict the most useful transmitter and receiver locations in utilizing auroral ionization for communication purposes. The studies also may suggest methods of minimizing the effects of auroral propagation when it is considered a detrimental propagating mode, for example, when it results in undesirable multipath effects. (Contractor's abstract)

STA.06:037

Stanford U. Stanford Electronics Labs., Calif.

FERRITE ATTENUATORS FOR TRAVELING-WAVE TUBES, by L. C. Bacon. Feb. 11, 1958, 175p. incl. diagrs. refs. (Technical rept. no. 26) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 153715 Unclassified

Several ways of employing ferrites in traveling-wave-amplifier attenuator systems are evaluated. The properties of conventional attenuators are reviewed with special attention given to the interrupted-circuited type. The phenomenon of nonreciprocal absorption in the region of resonance for a gyromagnetic material is considered, in a discussion of the experiments with the use of ferrites in conjunction with TWT's, several difficulties are pointed out, including dielectric loading, beam defocusing, and alteration of circuit phase velocity. Suggestions for ameliorating the conditions are given. A modified version of S. E. Miller's coupled-mode theory is employed to study 2 methods of utilizing nonreciprocal coupled helices with ferrites based above resonance. A description is

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given of the design and operation of a high power circuit or a traveling-wave amplifier circuit that uses a ferrite attenuator. Comparison is made with the performance of a severed circuit attenuator. The general characteristics of the ferrite attenuators are briefly discussed.

STA.06:038

Stanford U. Stanford Electronics Labs., Calif.

MULTI-STAGE, NARROW-BAND AMPLIFIERS EMPLOYING NONUNILATERAL ELECTRON DEVICES, by M. Lim. Feb. 11, 1958, 108p. incl. diagrs. refs. (Technical rept. no. 27) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 157096

Unclassified

An investigation was undertaken to formulate a method for the design of multi-stage, narrow-band, transistor amplifiers. Toward this objective, a complete analysis was undertaken of the transducer gain of a multi-stage, narrow-band, iterative amplifier employing 2-terminal interstages with ideal coupling transformers, and the transducer gain of the amplifier subsequently optimized with respect to the input and output terminations and the interstage networks of the amplifier. The optimum transducer gain of the amplifier was expressed in terms of an amplifier design parameter γ . It is shown that γ is directly related to the conductance level of the amplifier. A general design method for multi-stage narrow-band amplifiers employing general 2-port active devices was formulated, with the general design criteria that, for an amplifier employing inherently stable, active devices, the amplifier so designed should develop maximum transducer power gain; for an amplifier employing potentially unstable active devices, the amplifier so designed should develop optimum transducer power gain with a certain prescribed margin of stability. The stability margin for the amplifier is related to γ , or the conductance level of the amplifier. The control of the stability of the amplifier is effected through appropriate choice of γ . Experimental evidence obtained from actual amplifier performance indicates favorably the validity of the theoretical formulations.

STA.06:039

Stanford U. Stanford Electronics Labs., Calif.

THERMAL-VELOCITY EFFECTS IN TWO-DIMENSIONAL ELECTRON BEAMS, by C. B. Crumly. Feb. 25, 1958, 49p. incl. illus. tables, refs. (Technical rept. no. 457-2) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [Nonr-22524] and DA 36-039-sc-73178) AD 159576

Unclassified

Because of the growing importance of two-dimensional sheet or strip beams and hollow beams in microwave

devices, a need has arisen for design data applicable to these cases. Data are presented on space-charge-limited flow, applicable to the design of convergent Pierce guns for strip beams. The nonthermal case is treated first, in order to lay the foundation for the thermal case which follows. This treatment allows calculation of the trajectory of a strip beam with zero emission velocity and includes a provision for taking into account the effect of the anode lens. A first-order analysis of the effects of initial transverse velocities is presented, following the method of Cutler and Hines. The results indicate that the beam trajectory can be calculated, including the effects of both space charge and thermal velocities. The general nature of the results is the same as in the pencil-beam case, i.e., the beam becomes thicker at points of high convergence, and the point of minimum thickness is shifted toward the cathode. The theoretical results are applied to an example taken from an experimental tube. The nonthermal strip-beam analysis can be applied under certain conditions to the case of a convergent hollow beam, and design data for this case are presented. (Contractor's abstract)

STA.06:040

Stanford U. Stanford Electronics Labs., Calif.

GAIN, BANDWIDTH, AND NOISE CHARACTERISTICS OF THE VARIABLE-PARAMETER AMPLIFIER, by H. Heffner and G. Wade. Feb. 26, 1958, 32p. incl. diagrs. (Technical rept. no. 28) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-22524) AD 153170

Unclassified

Also published in Jour. Appl. Phys., v. 29: 1321-1331, Sept. 1958.

The variable parameter (or parametric) principle of amplification is characterized by a typical arrangement in which a variable energy-storage element, such as an inductor or a capacitor, is suitably coupled to two resonant circuits. If the value of the energy-storage element is made to vary in the proper way, energy is fed from the source which drives the element (that is, the pump) to the fields of both the resonant circuits. This paper describes the behavior relative to gain, bandwidth and noise of this type of amplifier. Specifically, it is shown that to increase gain, the Q of one of the resonant circuits, the one commonly called the idling circuit, must be increased or the variation in the variable reactance must be increased. The bandwidth is inversely proportional to this Q and to the voltage gain. Hence, for high gain, the amplifier is normally a narrow-band device. One of the most important sources of noise is the thermal noise originating in the idling circuit. However, in principle this source can be reduced indefinitely by making the idling frequency approach the pumping frequency or by artificially cooling the idling circuit. In this fashion very low noise figures should be possible. The parametric principle can also be applied

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to producing frequency conversion with large conversion gain. The appendix presents the expressions for gain, bandwidth and noise figure for this application. The behavior of the converter relative to gain, bandwidth and noise is quite similar to that of the amplifier. (Contractor's abstract)

STA.06:041

Stanford U. Stanford Electronics Labs., Calif.

OBLIQUE ECHOES FROM OVER-DENSE METEOR TRAILS, by L. A. Manning. Feb. 28, 1958, 20p. incl. diagrs. (Technical rept. no. 29) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 157095 Unclassified

Ray paths are computed for waves refracted by meteor trails having a Gaussian radial distribution of ionization density. From the spreading of initially parallel rays as they pass through the trail, a measure of reflected signal intensity versus scattering angle is obtained; the results are presented in polar scattering diagrams, valid in the limit of large trail size. Equivalence theorems are derived relating both intensity and scattering angle for rays incident upon the trail at an arbitrary angle to the intensity, and scattering angle for rays incident in the plane normal to the trail. Curves are presented showing the dependence of echo duration of forward-scatter angle with trail orientation as parameter; it is found that the $\sec^2 \theta$ law developed for underdense trails applies to over-dense trails only if the plane of propagation contains the trail axis. If not, the effective secant exponent may be as small as 0.3. The theory is compared with McKinley and McNamara's duration measurements. It is found that although the general agreement is satisfactory, the details of their experimental results depend on the way that winds change the trail orientation. The ray theory is also compared with Keitel's wave theory solution. Unfortunately, he could not get wave solutions for dense trails of age greater than 0.357% of the minimum echo duration. Even so the ray solutions agree with Keitel's results for scatter angles up to 155° , thus including all angles available to ground based stations. (Contractor's abstract)

STA.06:042

Stanford U. Stanford Electronics Labs., Calif.

INVESTIGATION OF THE TRANSVERSE-FIELD KLYSTRON, by B. Fank. Mar. 10, 1958, 79p. incl. illus. (Technical rept. no. 305-1) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under [Nonr-22524]) AD 159571 Unclassified

A theoretical and experimental investigation was made of the noise characteristics of a transverse-field tube. The transverse-field klystron was chosen as the simplest type of such tube for the investigation. A theory of operation was developed which includes expressions for tube transconductance, beam loading, and noise figure. Three low-frequency experimental klystrons were built to test the theory. The fundamental beam noise in a transverse-field tube is due to two independent sources: (1) the transverse velocity fluctuations, and (2) the transverse displacement fluctuations. Theoretical calculations using these two noise sources give relatively good agreement with experimental results. Although the experimental tubes were not low noise tubes, their agreement with the theory indicates the possibility that transverse-field klystrons can be designed to have low noise figures. (Contractor's abstract)

STA.06:043

Stanford U. Stanford Electronics Labs., Calif.

MICROWAVE INTERACTION OF ELECTRON BEAMS AND NON-PROPAGATING PERIODIC STRUCTURES, by J. A. Ruetz. Mar. 27, 1958, 145p. incl. diagrs. refs. (Technical rept. no. 30) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 156783 Unclassified

The possibility of obtaining gain in periodic nonpropagating structures is investigated. The analysis uses an equivalent circuit representation of the microwave structure. The electron beam is assumed to flow through constant-field gaps followed by field-free drift regions. The gap voltage is associated with 2 different voltages of the equivalent circuit. One case assumes that the gap-voltage is the voltage appearing across a part of the shunt branch of the equivalent circuit while the other case assumes that the gap-voltage is the voltage across part of the series branch of the equivalent circuit. By making TWT approximations, one case reduces to a Bernier type analysis while the other case uses a pierce type analysis. Various approximations to the characteristic equations are discussed, and regions of validity of these approximations are investigated. The equations expressing the excitation conditions are derived in terms of the characteristic roots for the 2 types of representations. Expressions are derived relating the microwave structure to the equivalent circuit. Measurements or calculations are performed on the microwave structure to determine the circuit parameters. A calculation for a folded rectangular waveguide structure including initial modulation conditions is presented. The gain is found to be very dependent upon the terminating impedance of the structure.

STA.06:044 - STA.06:047

STA.06:044

Stanford U. Stanford Electronics Labs., Calif.

AN APPLICATION OF THE THEORY OF GAMES TO RADAR RECEPTION PROBLEMS, by N. J. Nilsson. Apr. 21, 1958, 108p. incl. diagrs. refs. (Technical rept. no. 704-1) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 203099

Unclassified

Presented at IRE National Convention, New York, Mar. 23-26, 1959.

Also published in I.R.E. National Convention Record, Pt. 4: 130-140, 1959.

An investigation revealed that radar reception in the presence of jamming noise contains the elements of a conflict situation and is therefore a problem in the theory of games. The radar operators are constrained to a certain average power and a matched filter is the radar receiver. The design variable for the radar operators is the shape of the power spectral density function. The jammers, also, may choose a power spectral density function subject to an average power limitation. These spectral shapes comprise the strategies for both teams in a game. Various criteria of performance of the radar are determined by the spectral shapes chosen by each team. These criteria—the output signal-to-noise ratio, the mean square range error, and the mean square velocity error—are each, in turn, made the payoff function of the game. Analysis of each of these games reveals optimum spectral shapes from the point of view of both the jammers and the radar operators. When signal-to-noise ratio is the payoff function, constant-density, band-limited spectra are optimum for both teams. The optimum spectra associated with the other two payoff functions are discovered after finding a method to simplify the resulting games. (Contractor's abstract)

STA.06:045

Stanford U. Stanford Electronics Labs., Calif.

BAYES ESTIMATION OF RADAR SIGNAL PARAMETERS, by J. E. Keigler. Apr. 21, 1958, 67p. incl. diagrs. refs. (Technical rept. no. 35) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 160470

Unclassified

The concepts of statistical decision theory are applied to the problem of evaluating the parameters of a returned radar signal immersed in noise, these parameters being related to the properties of the target. It is shown that the Bayes estimation procedure is the logical procedure to use in a practical radar system and that the bounded absolute error loss function is more

appropriate to many radar situations than the customary squared error. On these premises, receivers are designed for several types of targets. The principal part of these receivers is the posteriori probability density computer which utilizes delay lines and relatively short duration impulse-response matched filters to obtain correlation between the transmitted and received signals over a much longer period. A bonus feature of some of the derived receivers is the simultaneous solution of both the detection and estimation problems. Finally, the performance of the Bayes receiver in terms of average risk, which is measured by the Monte Carlo method, is discussed. (Contractor's abstract)

STA.06:046

Stanford U. Stanford Electronics Labs., Calif.

EXTERNAL-CIRCUIT TRAVELING-WAVE AMPLIFIERS, by G. A. Loew. Apr. 21, 1958, 157p. incl. illus. diagrs. tables, refs. (Technical rept. no. 34) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 159573

Unclassified

Research is concerned with the study of external-circuit traveling-wave amplifiers. The inspection of the propagation and interaction characteristics of various lumped and distributed filter circuits points to 3 potential slow-wave structures for wide-band amplifier operation: (1) lumped filter networks of the bandpass type using negative-mutual inductive coupling between sections, (2) simultaneously loaded and grounded helices, and (3) single-ended loaded helices. The theory, design, construction, and operation of each of these structures is investigated. Considerable experimental evidence is given to demonstrate the possibilities as well as the limitations of these circuits with regard to size, interaction impedance, matching, bandwidth, attenuation, and gain. The results are examined in the light of existing traveling-wave tube theory. Amplifier operation is obtained in the region between 150 and 500 mc with relative bandwidths up to 50% and average gains up to 25 db. A method is presented to design attenuation in the form of resistance paper applied onto the circuits. Experimental verification of this method is included.

STA.06:047

Stanford U. Stanford Electronics Labs., Calif.

THE HELITRON OSCILLATOR, by G. Wada. Apr. 21, 1958, 90p. incl. diagrs. refs. (Technical rept. no. 31) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 159570

Unclassified

Also published in Proc. Inst. Radio Engineers, v. 46: 1700-1705, Oct. 1958.

STA.06:048 - STA.06:051

The theoretical and experimental behavior of the heli-tron oscillator was investigated. Basically the tube utilizes Harris-flow focusing; the beam travels in a helical path in which the centrifugal force on the electron is balanced by an inward electric-field force. The principal feature of this device, as distinguished from the Russian spiratron, is that interaction between the beam and circuit is such that gain in circuit field is obtained at the expense of change in potential energy of the beam. Experimental data on the 3 tubes indicated continuous voltage tuning from 1.2 to 2.4 kmc with an accompanying change in tuning voltage of from 650 to 1700 v. Power output was in the vicinity of 1 to 10 mw; and start-oscillation current was approximately 0.4 ma for a structure 4 in. long.

STA.06:048

Stanford U. Stanford Electronics Labs., Calif.

INTERSTAGES FOR TRANSISTOR VIDEO AMPLIFIERS, by J. J. Spilker. Apr. 21, 1958, 130p. incl. diagrs. refs. (Technical rept. no. 33) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 161327
Unclassified

This study presents a method of designing interstages for transistor video amplifiers. The transistors are represented by the hybrid- π equivalent circuit. The problem of designing interstages is shown equivalent to the problem of synthesizing a transfer impedance function proportional to the stage gain where the resulting interstage network must have certain specified terminating impedances. These terminating impedances represent the effects of the transistors. The interstage synthesis technique developed emphasizes the importance of the interstage using a limited number of elements and providing a satisfactory gain-bandwidth product. Actual synthesis need never be completed until it is certain a satisfactory gain-bandwidth-product can be obtained with a given method of realization. Interstages synthesized using this interstage synthesis technique compare favorably with previously developed interstages. A set of general theoretical limitations on gain-bandwidth product have been derived. Specific limitations have been developed for two and three-terminal interstages, and it has been found quite important to specify whether or not transformers are allowed. The use of these limitations has required the derivation of a new more general resistance integral theorem. (Contractor's abstract)

STA.06:049

Stanford U. Stanford Electronics Labs., Calif.

THE USE OF DOPPLER SHIFT FOR THE DIRECTIONAL RESOLUTION OF RECEIVED SIGNALS, by E. Gehrels. Apr. 21, 1958, 125p. incl. diagrs. refs.

(Technical rept. no. 32) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 161326
Unclassified

A new principle was developed for the purpose of resolving multiple signals arriving from different directions in space. The principle and the theoretical properties are presented and the realizability of a system embodying the principle is demonstrated. The unconventional techniques encountered present special problems in circuit design which are discussed in detail. A thorough experimental demonstration of some of the critical operations including those not subject to exact prediction by theory is described. The principle of directional resolution using a moving antenna can be used to produce the equivalent of any antenna system and is really an extension of the sampling theorem to a space field problem. (Contractor's abstract)

STA.06:050

Stanford U. Stanford Electronics Labs., Calif.

MODIFIED MULTIFILAR HELICES FOR USE IN WIDE-BAND TRAVELING-WAVE TUBES, by D. G. Dow. May 23, 1958, 111p. incl. illus. diagrs. refs. (Technical rept. no. 37) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 201478
Unclassified

The utilization of a multifilar helix as a slow wave circuit in a traveling-wave amplifier is discussed with special emphasis on the bifilar helix. A method of strapping the bifilar helix with rods directly through the center was developed. Slow-wave circuits with mode-selective loss and mode-selective stop bands were designed and constructed with the objective of eliminating the backward-wave oscillation in the anti-symmetric mode while affecting only slightly the desirable forward-wave properties of the symmetric mode. A typical circuit has a stop band in the anti-symmetric mode 50% wide in frequency, a forward-wave bandwidth of almost two to one and impedance about two-thirds that of a simple bifilar helix operated in the same mode. In addition to extensive theoretical calculations and cold-circuit measurements, two models of an experimental traveling-wave tube were constructed and operated in good agreement with the theoretical expectations.

STA.06:051

Stanford U. Stanford Electronics Labs., Calif.

A LUMPED MODEL ANALYSIS OF NOISE IN SEMICONDUCTOR DEVICES, by R. N. Beatie. May 1958 [8]p.

STA.06:052 - STA.06:055

incl. illus. (Technical rept. no. 1505-1) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 227142
Unclassified

Also published in I.R.E. Trans. of Professional Group on Electron Devices, v. ED-6: 133-140, Apr. 1959.

A clear picture of the noise properties of semiconductor devices may be gained through a study of lumped models. When a semiconductor device is represented by a lumped model, it is found that all the noise may be accounted for by associating a noise-current generator with each of the conductances appearing in the lumped model. The expressions describing these noise-current generators are easily found, and the determination of the device noise properties involves only lumped model analysis. Such analysis to a diode model and a transistor model yields results which are in agreement with the results of other authors, and with experimental measurements cited by them. The mechanisms considered in this paper do not, however, account for the so-called $1/f$ noise. (Contractor's abstract)

STA.06:052

Stanford U. Stanford Electronics Labs., Calif.

ON THE SPECTRAL REPRESENTATION OF GAUSSIAN STOCHASTIC PROCESSES, by J. F. Bates. June 5, 1958, 28p. incl. diagrs. refs. (Technical rept. no. 39) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 162426
Unclassified

A method is advanced for expanding a class of gaussian stochastic processes in terms of a complete set of orthonormal functions such that the coefficients of the terms of the series expansion will be statistically independent. The class of processes considered are those whose correlation functions are the solutions of systems of linear, homogeneous differential equations with constant coefficients. (Contractor's abstract)

STA.06:053

Stanford U. Stanford Electronics Labs., Calif.

A TRANSISTORIZED LINEAR SWEEP CIRCUIT, by E. F. Yhap. June 5, 1958, 57p. incl. diagrs. (Technical rept. no. 38) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 162425
Unclassified

A study was conducted on a linear sweep generator composed of a triggered gate generator and a bootstrap circuit, with particular attention paid to the linearity of the sweep generator output voltage and to the effects of temperature on the gate generator. For this applica-

tion germanium junction transistors can be satisfactorily used, provided care is taken in the design of the circuit. The heart of the sweep generator lies in a bootstrap type of circuit, which requires an amplifier with high input impedance and close to unity amplification. A novel way of combining 2 transistors to meet these requirements is introduced. The constant-current pair, as it will be called, is compared to the Darlington pair, and it is shown that the former presents definite advantages in this application. A solution is presented for the recovery-time problem common to bootstrap circuits. It is shown that 3 transistors are sufficient to construct a triggered sweep generator, although four may be used if only very small amounts of non-linearity can be tolerated in the sweep voltage. (Contractor's abstract)

STA.06:054

Stanford U. Stanford Electronics Labs., Calif.

A STUDY OF AVALANCHE TRANSISTORS, by D. S. Gage. June 13, 1958, 120p. incl. diagrs. tables, refs. (Technical rept. no. 36) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524 and National Science Foundation) AD 162925
Unclassified

In the study of avalanche transistors, the simultaneous occurrence of avalanche multiplication and voltage punch-through was discovered to produce either large current pulses or pulses with a very fast rise time. An analysis of this mode of operation is given which includes some quantitative results and a description of the regenerative mechanism. The avalanche transistor was approximated by a model in order to analyze quantitatively circuits which utilize avalanche multiplication. The distributed system of the transistor can be approximated by a lumped model. The lumped model represents the flow of holes and electrons by drift and diffusion, the p-n junction relationships, the displacement currents, and avalanche multiplication within the transistor. The form of the resulting finite-difference equations does not permit their numerical solution to be usable unless the time interval in each step-by-step calculation is small. In the multiplication phenomenon, a consideration of the space charge of the conducting carriers in the depleted region is shown to account qualitatively for the dependence of avalanche multiplication upon voltage and current. Useful circuits are given for measuring the voltage at which punch-through occurs, the breakdown voltage, and the voltage at which the current gain of the transistor is unity.

STA.06:055

Stanford U. Stanford Electronics Labs., Calif.

EXPERIMENTAL CHARACTERISTICS OF A MICROWAVE PARAMETRIC AMPLIFIER USING A SEMICONDUCTOR DIODE, by H. Heffner and K. [L.]

STA.06:056 - STA.06:058

Kotzebue. [1958] [1]p. [Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-22524] Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 1301, June 1958.

The amplifier employs a back-biased germanium junction diode placed between central parts inside a rectangular cavity. With proper adjustments of the tuning screws, the cavity with diode in place can be made simultaneously resonant at 3500 mc, 2300 mc, and 1200 mc. Net gain up to 40 db has been obtained, although at such high gains the amplifier is extremely sensitive to load variations since no isolator or circulator is employed.

STA.06:056

Stanford U. [Stanford Electronics Labs.] Calif.

SOLID-STATE MICROWAVE AMPLIFIERS, by H. Heffner. July 25, 1958 [9]p. incl. illus. diagrs. tables, refs. (Technical rept. no. 56) [Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr-22524] AD 218021 Unclassified

Published in I.R.E. Trans. of Professional Group on Microwave Theory and Techniques, v. MTT-7: 83-91, Jan. 1959.

The maser and the parametric amplifier form a new class of microwave amplifiers which can exploit the properties of bound electrons in a solid. These amplifiers have several common characteristics, among them being their very low-noise performance. This paper reviews the method of operation of these amplifiers, discusses the performance achieved and achievable by the various versions, and points up some of the difficulties involved in effectively utilizing the extremely low-noise figures obtainable. A bibliography is included in which an attempt has been made to include all published papers on masers and parametric amplifiers.

STA.06:057

Stanford U. Stanford Electronics Labs., Calif.

APPLICATION OF "COMPARISON OF EXPERIMENTS" TO RADAR DETECTION AND CODING PROBLEMS, by N. M. Abramson. July 28, 1958, 85p. incl. diagrs. refs. (Technical rept. no. 41) [Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research under Nonr 22524] AD 201444 Unclassified

Presented at I.R.E. National Convention, New York, Mar. 24-27, 1958.

Also published in I.R.E. National Convention Record, Pt. 4: 22-26, 1958.

"Comparison of Experiments" is the name given to a recently developed topic in statistical decision theory. It deals not with the making of decisions but with the data (or experiment) upon which the decision is based. After a brief discussion of statistical decision theory and comparison of experiments in general, some practical methods are developed for comparing experiments with an infinite as well as a finite number of outcomes. Examples are then given of the application of these methods to radar detection and elementary binary coding. In the radar case comparison of experiments amounts to comparison of the signals used to detect a target. This application may therefore be coded comparison of radar signals. In the coding case the problem of signal repetition to provide reliability of data transmission is considered. The relationship between the number of repetitions and the probability of correct transmission of a single digit is investigated. (Contractor's abstract)

STA.06:058

Stanford U. Stanford Electronics Labs., Calif.

THE LINEAR LEAST SQUARES SYNTHESIS OF CONTINUOUS AND SAMPLED DATA MULTIVARIABLE SYSTEMS, by R. C. Amara. July 28, 1958, 130p. incl. diagrs. refs. (Technical rept. no. 40) [Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524] AD 201443 Unclassified

The class of systems treated in this report is that characterized by a multiplicity of inputs and outputs. For such linear multivariable systems subject to continuous and sampled stochastic inputs with arbitrary self- and cross-correlations, a derivation is made of the minimization equations to be satisfied by the optimum transfer-function matrix. The criterion of performance which is used is the minimization of the sum of the mean-square errors between the set of actual outputs and a set of desired outputs. In each case the errors are evaluated at all instants of time. The analysis divides the multivariable problem into two principal parts. In the first, designated the filter case, are included those systems in which the only restriction on the linear transfer-function matrix to be realized is that of physical realizability. Included in the second, the control case, are those systems in which a controlled matrix is specified which imposes additional restrictions on the overall performance of the system. The results of the analysis are presented compactly in matrix form. (Contractor's abstract)

STA.06:059

Stanford U. Stanford Electronics Labs., Calif.

SEMICONDUCTOR COMPARATOR CIRCUITS, by G. L. Hoehn, Jr. July 28, 1958, 85p. incl. diagrs. tables, refs. (Technical rept. no. 43) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 201445
Unclassified

Specific regenerative comparator circuits employing semiconductor diodes are studied and analyzed. Linear analysis reveals certain criteria useful in minimizing comparison errors due to temperature variations. Also linear analysis is found useful in the study of the limits imposed upon comparator accuracy by circuit noise. Nonlinear analysis is a necessary method for studying the transition region between stability and instability in regenerative circuits. Experimental studies substantiate the usefulness of temperature compensation techniques and the limit to which they may be carried. Measurements made at a constant temperature clearly indicate that noise within the comparator circuit limits the precision with which comparison can be effected.

STA.06:060

Stanford U. Stanford Electronics Labs., Calif.

SLALOM INJECTION FOR THE HELITRON OSCILLATOR, by J. L. Jones. July 28, 1958, 71p. incl. illus. diagrs. (Technical rept. no. 46) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 202509
Unclassified

The study is concerned with a new type of electron beam injection for the helitron oscillator. The helitron is a voltage-tuned backward-wave oscillator in which the focusing of the electron beam depends upon a balance between centrifugal force of helical motion and a radial electrostatic field. The injection mechanism is called slalom injection since the beam is first launched into a path like that of Slalom-Focusing and then injected from the slalom path into the concentric-cylinder geometry of the helitron. A physical description of the slalom injection scheme is followed by a discussion of electron-trajectory computations which were made using data measured on a 2-dimensional model painted on Teledeltos paper. A new electron gun was designed which produces a convergent strip beam. Test results indicated a 95% beam transmission out of the gun, although the shape of the beam and the minimum thickness were not entirely satisfactory. Test results with an experimental beam tester tube indicated a beam transmission of 40% of cathode current to the collector. A variation of 20 to 40% transmission was measured over a simulated tuning range of 2 to 1 in frequency. (Contractor's abstract)

STA.06:061

Stanford U. Stanford Electronics Labs., Calif.

A STUDY OF THE ITERATIVE METHOD OF NETWORK SYNTHESIS, by C. Y. Chang. July 28, 1958, 92p. incl. diagrs. tables, refs. (Technical rept. no. 44) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 201446
Unclassified

A study was conducted to introduce and demonstrate some properties of the iterative method of zero-pole network synthesis in the frequency domain, as well as to extend its applications. Maximally flat or equal ripple frequency response approximation is used in illustrations and applications. The philosophy of the iterative method consists of the choice of reasonable starting poles or zeros of a network function corresponding to a designated circuit configuration, and the repeated computation of zeros from poles and vice versa through the use of the realization and frequency response constraints, alternately, until it converges within the desired accuracy. Some special outcomes of the iterative process are identified and illustrated. A degeneration phenomenon makes some element values of the original circuit zeros or infinity ultimately as the iteration progresses. An oscillation phenomenon does not yield convergent solutions (even if a solution exists) but poles and zeros of the network function oscillate between two different sets of points. A quasi-divergence phenomenon behaves like a random process and does not converge practically. The last two phenomena justify a statement that the iterative method may not work even though a solution exists. A description of limitations of the iterative method, comparison of the equating-coefficient and Darlington's methods in the iterative computation, and a modified equation of iteration are given. Linear-phase networks with equal ripple approximation utilizing allpass transfer function are synthesized. Design charts for these allpass transfer functions of lower orders are computed. Applications to the synthesis of two-channel amplifier circuits and three-terminal pair networks are illustrated.

STA.06:062

Stanford U. Stanford Electronics Labs., Calif.

LUMPED MODELS OF TRANSISTORS AND DIODES, by J. G. Linvill. Aug. 28, 1958 [12]p. incl. diagrs. (Technical rept. no. 48) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524, and National Science Foundation) AD 203048
Unclassified

Also published in Proc. Inst. Radio Engineers, v. 46: 1141-1152, June 1958.

Lumped models are shown which can be used to approximate the properties of transistors and diodes over a wide

STA.06:063 - STA.06:066

range of conditions and applications. Two analytical procedures lead to a lumped model approximating a distributed system. In the familiar one, a differential analysis of the distributed system is made, subsequently a rational approximation is made to the transcendental functions resulting from the differential analysis. In the other, one makes a lumped model at the outset to approximate the distributed system and analyzes it. The lumping approximation at the outset generally amplifies the analysis and permits consideration of phenomena which would be prohibitive to analyze on a differential basis. Throughout, it provides a close tie of analysis to the physical phenomena involved. A lumped model for diffusion transistors is shown which is analogous in end result to the Ebers-Moll model. The simple model is subsequently amended to account for the drift phenomenon, photo effects and avalanche multiplication. (Contractor's abstract)

STA.06:063

Stanford U. Stanford Electronics Labs., Calif.

SENSITIVITY OF ACTIVE NETWORKS TO VARIATIONS IN INTERNAL PARAMETER, by E. M. Davis, Jr. Aug. 29, 1958, 159p. incl. diagrs. refs. (Technical rept. no. 47) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 203049 Unclassified

An important consideration in the design of an amplifier is the extent to which the amplifier's performance can be desensitized to changes in its active elements. The three possible methods of achieving gain constancy despite changes in the parameters of a linear network are described. The sensitivity of the amplifier's gain to parameter variations is mathematically defined both for the case of differential changes in elements and for the case of large changes. The over-all gain of a linear circuit is shown to be a bilinear transformation of any internal element. The conditions necessary for amplification to be independent of changes in the active elements are presented in terms of the coefficients of the bilinear transformation and also in terms of circuit (or system) parameters. The sensitivity of the amplification of a linear network to changes in an internal two-terminal element is proportional to the impedance mismatch existing between that element and the remainder of the circuit. A measure, related to mismatch in the two-terminal case, is given which is proportional to the sensitivity to variations of transfer parameters.

STA.06:064

Stanford U. Stanford Electronics Labs., Calif.

MINIMUM NOISE FIGURE OF A PARAMETRIC AMPLIFIER, by H. Heffner and G. Wade. [1958] [1]p.

incl. diagrs. (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) Unclassified

Published in Jour. Appl. Phys., v. 29: 1262, Aug. 1958.

The noise figure is quoted and it is shown that it will approach a minimum value equal to the ratio of the pumping to the idling frequency.

STA.06:065

Stanford U. [Stanford Electronics Labs.] Calif.

GAIN, BANDWIDTH AND NOISE IN A CAVITY-TYPE PARAMETRIC AMPLIFIER USING AN ELECTRON BEAM, by G. Wade and H. Heffner. Oct. 2, 1958 [13]p. incl. diagrs. refs. (Technical rept. no. 54) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 212293 Unclassified

Also published in Jour. Electronics and Control, v. 5: 497-509, Dec. 1958.

A modulated electron beam flowing across the gap of a resonant cavity can change the gap capacitance at the modulating frequency, thus producing the variable capacitance needed for a parametric amplifier. Such a beam-type parametric amplifier has been proposed independently by the authors and by T. J. Bridges and has been constructed by Bridges. This paper presents an investigation of the gain, bandwidth, and noise figure which can be expected. It shows that complete cancellation simultaneously of the two uncorrelated noise sources in the electron beam, while feasible in principle, is virtually impossible in practice. The conflicting requirements of large beam current for acceptable capacitance variation and large plasma wavelength for optimum noise cancellation lead to practical minimum noise figures in the vicinity of 3 db. A design example is worked out for an amplifier with pump frequency at 2000 mc amplifying at 500 mc/s with a gain of about 15 db. The resulting bandwidth is 43 kc. A noise figure of 3.4 db could be achieved with some difficulty. (Contractor's abstract)

STA.06:066

Stanford U. Stanford Electronics Labs., Calif.

COUPLING NETWORK DESIGN USING DISCRETE-FREQUENCY DATA, by P. A. Ligonides. Oct. 22, 1958, 179p. incl. tables. (Technical rept. no. 45) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 206210 Unclassified

A method for the design of practical lossless ladder networks, based on a point-by-point matching in the frequency domain, is described. The load-terminating

STA.06:067 - STA.06:069;
STA.21:001

Impedance and the desired input impedance to the coupling network when so terminated, are described in the data by values at a number of discrete frequencies (as might result from source and load measurements). The values of the electrical elements in the coupling structure are related by convenient means to its matching properties. A simple design procedure is developed, for two- and three-element ladders, by minimizing the mean-square error in the desired input admittance or impedance at the frequencies considered in the data. The minimization procedure is simple enough when three variables (electrical elements) are involved--and for most practical cases two- and three-element networks are satisfactory on account of their simplicity. (Contractor's abstract)

STA.06:067

Stanford U. Stanford Electronics Labs., Calif.

A SEMICONDUCTOR-DIODE PARAMETRIC AMPLIFIER AT MICROWAVE FREQUENCIES, by K. L. Kotzebue. Nov. 4, 1958, 66p. incl. illus. (Technical rept. no. 49) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 206202 Unclassified

A microwave parametric amplifier is examined both theoretically and experimentally. The usual small-signal theory of "three-frequency" parametric amplifiers is presented and extended, yielding information regarding the large-signal behavior as well as the small-signal performance. Expressions are developed for the small-signal gain, bandwidth, and noise figure; and approximate large-signal expressions are developed for the saturated power output, the required pump power to start oscillation, the power output as an oscillator, and the efficiency as an amplifier and oscillator. Assuming that the variable-reactance element used in the parametric amplifier is a back-biased semiconductor diode, minimum diode characteristics are obtained in terms of the diode "Q" and fractional capacitance swing. (Contractor's abstract)

STA.06:068

Stanford U. Stanford Electronics Labs., Calif.

AIR MOTIONS AND THE FADING, DIVERSITY, AND ASPECT SENSITIVITY OF METEORIC ECHOES, by L. A. Manning. Dec. 10, 1958, 29p. incl. illus. refs. (Technical rept. no. 50) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force Office of Scientific Research] under Nonr-22524) AD 211624 Unclassified

A theory is presented that discusses those properties of meteoric echoes that depend on distortion of the trail by winds. The existing results concerning the delay in the start of echo fading (Greenhow), the delay in echo

appearance with aspect (McKinley and Millman), the spectral composition of the received signal (Manning, Villard, and Peterson), and the regularity of the fading pattern, are quantitatively explicable. In addition, the theory predicts that the ensemble average rate of echo fading should rise characteristically with time and should then drop precipitously at the end of the ensemble echo. Moreover, it predicts that the correlation of fading patterns at two ground receivers should be a Gaussian function of the product of receiver spacing and echo fading cycle-number. Experimental results are given confirming these predictions and making possible the determination of the principal properties of the wind profile. It is concluded that at the times of observation the small-scale cut-off wavelength of the turbulence spectrum was about a kilometer, that lack of correlation of wind velocities existed in a vertical range of about a scale height, that the rms variable component of N-S wind velocity was about 50 m/s, and that the rms value of the relative maxima of the vertical gradient of a component of the wind velocity was about 100 m/s. These figures agree with photographic studies of meteor trails made by Whipple. (Contractor's abstract)

STA.06:069

Stanford U. Stanford Electronics Labs., Calif.

A CLASS OF SYSTEMATIC CODES FOR NON-INDEPENDENT ERRORS, by N. M. Abramson. Dec. 30, 1958, 31p. incl. illus. tables (Technical rept. no. 51) (Sponsored jointly by Office of Naval Research, Signal Corps, and Air Force [Office of Scientific Research] under Nonr-22524) AD 209682 Unclassified

A class of systematic codes has been obtained which will correct all single errors and all double errors occurring in adjacent digits. These codes use significantly fewer checking digits than codes which correct all double errors. In addition, because of inherent regularities in their structure, these codes may be instrumented in a strikingly simple fashion. (Contractor's abstract)

STA.21:001

Stanford U. Stanford Electronics Labs., Calif.

REFLECTION AND TRANSMISSION AT A SHARPLY-BOUNDED IONOSPHERE, by I. W. Yabroff. July 29, 1957, 70p. incl. diagrs. refs. (Technical rept. no. 1) (AFOSR-TN-57-466) (AF 18(603)126) AD 136457 Unclassified

Experimental evidence indicates the ionosphere can be treated as sharply-bounded for radio waves incident from below at frequencies less than 200 kc. Equations are derived for the calculation of reflection coefficients and characteristics of the waves excited within the ionosphere such as the direction of phase and energy

STA.21:002 - STA.21:004; STT.01:001

propagation, phase velocity and attenuation rate. These equations are valid at all frequencies and any arbitrary angle of incidence. A complete set of curves is shown for an isotropic medium and some curves are shown for an ionosphere with the earth's magnetic field included. At very low frequencies, it is shown that the reflection coefficients are independent of azimuthal angle of incidence, to a first approximation. The "quasi-longitudinal" approximation, which is often used at very low frequencies, is shown to give reflection coefficients which are accurate to within ten percent when the plasma frequency is larger than twenty times the wave frequency. However, the calculated wave normal and ray directions within the ionosphere are very much in error when this approximation is used. The case of incidence from within the ionosphere is treated and a sample calculation is shown.

STA.21:002

Stanford U. [Stanford Electronics Labs.] Calif.

REFLECTION AT A SHARPLY-BOUNDED IONOSPHERE, by I. W. Yabroff. [1957] [4]p. incl. diagra. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)126 and AF Cambridge Research Center under AF 19(604)785) Unclassified

Presented at Symposium on Propagation of Very-Low-Frequency Electromagnetic Waves, Boulder, Colo., Jan. 23-25, 1957.

Published in Proc. Inst. Radio Engineers, v. 45: 750-753, June 1957.

A quantitative description of the waves transmitted into and reflected from a sharply-bounded, anisotropic ionosphere with losses is given. Given curves show the effects of the earth's field and losses for a particular model of the nighttime E layer at vlf. (Contractor's abstract)

STA.21:003

Stanford U. [Stanford Electronics Labs.] Calif.

OBSERVATIONS OF MAGNETO-IONIC DUCT PROPAGATION USING MAN-MADE SIGNALS OF VERY LOW FREQUENCY, by R. A. Helliwell and E. Gehreis. [1958] [3]p. incl. diagra. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)-126, Office of Naval Research under Nonr-22527, and National Science Foundation) Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 785-787, Apr. 1958.

A unique mode of very-low-frequency radio transmission

called magneto-ionic duct propagation provides new evidence in support of the Eckersley-Storey theory of whistlers.

STA.21:004

Stanford U. [Stanford Electronics Labs.] Calif.

COMPARISON OF WHISTLERS WITH MAGNETO-IONIC DUCT SIGNALS FROM STATION NSS (Abstract), by R. A. Helliwell and E. Gehreis. [1958] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research] under AF 18(603)126 and [Office of Naval Research] under Nonr-22527) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., Apr. 23-26, 1958.

Published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-6: 312, July 1958.

The time delays of one-hop whistlers and echoes from NSS (near Washington, D. C.), were measured at Cape Horn on 15.5 kc. They correlated closely, even though their day-to-day variations were large. The whistler variations could not, therefore, be attributed to changes in the location of the causative lightning flashes. At Washington, D. C., there were eighteen two-hop whistlers which were coincident at Cape Horn. Their dispersions were thirty per cent greater, on the average, than twice those at Cape Horn. If the propagation path had been the same for the Cape Horn and Washington whistlers, the dispersion ratio should have been exactly two. These results are compared with NSS split-echo data and recent whistler data from the IGY program. The study provides new evidence that magneto-ionic duct signals are often restricted to discrete paths. Two possible models for such paths are compared. They are based on (1) columns of field-aligned ionization extending into the outer ionosphere and (2) irregularities in the E or F2 layer. Tape recordings of whistlers at Washington, D. C., were kindly supplied by H. E. Dinger of the Naval Research Laboratory.

STT.01:001

Stevens Inst. of Tech., Hoboken, N. J.

PLASMA MOTORS, by W. H. Bostick. [1958] [11]p. incl. diagra. table. (AF 49(638)156) Unclassified

Presented at Conf. on Advanced Propulsion, Los Angeles, Calif. Dec. 12, 1957.

Published in Proc. Fourth annual meeting of the Amer. Astronaut. Soc., New York (Jan. 29-31, 1958), N. Y., Amer. Astronaut. Soc., 1958, p. 2-1 - 2-11.

Also published in I. R. E. National Convention Record, Pt. 9: 28-36, 1958.

SUN.01:001 - SUN.01:003;
SYR.01:017

It has been demonstrated that plasma consisting of titanium ions, deuterium ions, and electrons can be propelled by a small button plasma gun at speeds up to 2×10^7 cm/sec. Plasma motors employing rails should be able to obtain speeds of 10^8 cm/sec without any difficulty. The corresponding specific impulse is 10^5 sec. Several types of plasma motors are discussed. (Contractor's abstract)

SUN.01:001

Sundstrand Machine Tool Co. Sundstrand Turbo Div.,
Pacoima, Calif.

SPRAY FORMATION AND BREAKUP AND SPRAY COMBUSTION, by A. E. Fuhs. Feb. 5, 1958, 129p. (Rept. no. AMF/TD 1199; technical note no. 4) (AFOSR-TN-58-414) (AF 18(603)107) AD 158217

Unclassified

This report is a survey of the literature in the field of liquid spray behavior. Part I is a discussion of the known means for atomizing liquids and the mechanisms for jet and sheet breakup under the various environments of non-burning media. The subsequent distributions and behavior of liquid drops in sprays are then examined. Application to rocket motors of sprays formed by impinging jets is considered in some detail. Part II deals with those aspects of sprays associated with the combustion process. Mixing of propellants is considered first. Then the empirical laws of evaporation are reviewed, both for single droplets and for sprays. Finally spray combustion is examined. It is concluded that the combustion process is quite complex in that it involves the interaction of many physical and chemical rate processes, the details of which still pose a formidable challenge. Nevertheless, our understanding of the essential features of spray combustion has progressed sufficiently to permit reasonable semi-empirical correlations in terms of measurable quantities. (Contractor's abstract)

SUN.01:002

Sundstrand Machine Tool Co. Sundstrand Turbo Div.,
[Pacoima, Calif.]

THE EXPERIMENTAL DETERMINATION OF CHEMICAL CONVERSION TIMES IN LIQUID FUEL ROCKET ENGINES, by J. W. Bjerklie. Mar. 15, 1958, 17p. incl. diags. (Rept. no. S/TD 1232; technical note no. 5) (AFOSR-TN-58-415) (AF 18(603)107) AD 158218; PB 148264

Unclassified

The experimental determination of effective time delays in rocket engines according to Barrère: Two alternate methods of interpretation are described mathematically based on the assumptions of concentrated and distributed combustion. Analysis of pressure decay at the time of

propellant shutoff and its relation to chemical conversion time, τ , in rocket thrust chamber: The case of distributed combustion is analyzed by starting with a law of burning sprays which has been shown to be in good agreement with experiments. The results for both analyses of distributed combustion are shown to be identical.

SUN.01:003

Sundstrand Machine Tool Co. Sundstrand Turbo Div.,
[Pacoima, Calif.]

SELECTED SCALING PROCEDURES FOR LIQUID-FUEL ROCKET ENGINES, by S. S. Penner. Mar. 31, 1958, 14p. (Rept. no. S/TD 1241; technical note no. 6) (AFOSR-TN-58-416) (AF 18(603)107) AD 158219; PB 144656

Unclassified

The scaling rules of intermediate scope were considered and included studies of (1) scaling with maintenance of stability for high- and low-frequency motor oscillations, and (2) scaling with maintenance of similarity for selected Reynolds numbers and for high-frequency stability. The approaches investigated in the latter study included (1) Crocco's procedure of using a fixed injector configuration and constant chamber Reynolds number, and (2) constant Reynolds number based on the spacing of fuel and oxidizer injector orifices. The interplay of spray formation, evaporation and chemical reactions, superimposed on the complex flow patterns in real engines, presented interpretive and analytical problems. The studies on similarity analysis and engine scaling indicated that the requirements for similarity of some important aspects of engine combustion were mutually contradictory. The studies suggested a need for an experimental program which may lead to logical procedures for optimizing the required violation of the similarity rules. (Contractor's abstract)

SYR.01:017

Syracuse U. Dept. of Mathematics, N. Y.

ANALYTIC INVESTIGATIONS OF MARKOV CHAINS, by W. B. Jurkat. Setp. 1957 [12]p. (Research rept. no. 17) (AFOSR-TN-57-643) (AF 18(600)760) AD 136629

Unclassified

An investigation is made of Markov chains to point out that the properties of Markov processes satisfying certain conditions are true even for generalized processes. A matrix function $P(t) = (p_{jk}(t))$ is a generalized Markov process if (1) $0 \leq p_{jk}(t) < \infty$, (2) $p_{jk}(s+t) = \sum_m p_{jm}(s) p_{mk}(t)$, and (3) $\lim_{t \rightarrow 0} p_{jk}(t) = \delta_{jk} = p_{jk}(0)$, where the indices j, k, m range over all non-negative integers, the parameters s, t range over all positive real numbers, and δ_{jk} is the Kronecker symbol. An ordinary Markov process is supposed to be substochastic

SYR.01:018 - SYR.01:022

(a) $\sum_k p_{jk}(t) \leq 1$, $j = 0, 1, \dots$; $t > 0$. Of probabilistic interest are regular Markov processes which are supposed to be strictly stochastic, (b) $\sum_k p_{jk}(t) = 1$, $j = 0, 1, \dots$; $t > 0$. Consideration is given the processes satisfying conditions a and b. The analytic theory developed attains a symmetric status since rows are not preferred and the transposed matrix $P^*(t)$ also satisfies condition 1, 2, and 3. The known results are completed for ordinary Markov processes, and some new results are obtained. Discussions are presented of semigroups of positive matrices, semigroups of Toeplitz matrices, and semigroups of symmetric matrices. (ASTIA abstract)

SYR.01:018

Syracuse U. [Dept. of Mathematics] N. Y.

REMARKS ON AN ERGODIC THEOREM OF CHUNG, by L. J. Cote. Sept. 1957, 6p. (Research rept. no. 16) (AFOSR-TN-57-646) (AF 18(600)760) AD 136632
Unclassified

A Markov chain ergodic theorem can be used to prove a certain convergence theorem; consequences of this result are given. (Contractor's abstract)

SYR.01:019

Syracuse U. [Dept. of Mathematics] N. Y.

THE LIMIT DISTRIBUTIONS FOR SUMS OF MARKOV CHAIN VARIABLES WITHOUT SECOND MOMENTS, by L. J. Cote. Sept. 1957 [7]p. (Research rept. no. 15) (AFOSR-TN-57-647) (AF 18(600)760) AD 136633
Unclassified

Proof is completed for the limit distributions of sums of Markov chain variables without second moments. With notation taken from a previous study, let $\{X_n\}$ be a stationary Markov chain whose states, the non-negative integers, form a positive recurrent class; let the recurrence time distribution for some state i have a $(1 + \delta)^{\text{th}}$ moment; if $f(\cdot)$ is any real-valued function of integers such that for all constants, A ,

$$Z_1 = \sum_{\alpha=0}^{v_2-1} [f(X_\alpha) - A]$$

has a distribution in some stable domain with characteristic exponent $\neq 1$, then $S_n = \sum_{\alpha=0}^{n-1} f(X_\alpha)$, when properly

normed has a stable distribution. The following assumptions are made: (1) for every A the distribution of the Z_v is in some stable domain with characteristic expo-

nent different from unity; and (2) the recurrence time distribution for state i has a $(1 + \epsilon)^{\text{th}}$ moment. The norming constants, B_{ρ_i} , are similar to those of Doeblin which are the sums of the norming constants for the Y_v and those for the recurrence times. Condition 2 may be lightened since it is imposed to avoid difficulty in choosing the B_{ρ_i} .

SYR.01:020

Syracuse U. [Dept. of Mathematics] N. Y.

DOEBLIN'S THEORY OF MARKOV PROCESSES I, by K. L. Chung. Sept. 1957, 12p. (Research rept. no. 14) (AFOSR-TN-57-648) (AF 18(600)760) AD 136634
Unclassified

This report is the first installment of a general theory of Markov processes based on the work of Doeblin.

SYR.01:021

Syracuse U. [Dept. of Mathematics] N. Y.

ON MEAN FIRST PASSAGE TIMES, by S. D. Chatterji. Sept. 1957, 8p. (Research rept. no. 13) (AFOSR-TN-57-649) (AF 18(600)760) AD 136635
Unclassified

Proof is given for some results connecting the mean first passage and recurrence times in a denumerable Markov chain with stationary transition probabilities with one class only which is recurrent positive. The Tauberian theorems on the generating functions of the first-passage distributions are employed. All states discussed are assumed to belong to one recurrent positive class.

SYR.01:022

Syracuse U. Dept. of Mathematics, N. Y.

MARKOV CHAINS AND RELATED PROCESSES, by K. L. Chung. Final rept. June 1953-Sept. 1957. Oct. 1957 [4]p. (AFOSR-TR-57-88) (AF 18(600)760) AD 136688
Unclassified

Five aspects of Markov chains were investigated during the contract period: (1) continuous parameter Markov chains, (2) discrete parameter Markov chains, (3) general Markov processes, (4) application to random walks, and (5) application to stochastic approximation. Important results include the first proof of the existence of a continuous derivative of the transition probability function $p_{ij}(t)$ when i is a stable state; the first nontrivial instance of the strong Markovian property; and the

SYR.01:023-025; SYR.09:001, 002

discovery that analytical results can be obtained without any assumption regarding the row sums of the matrix, thus rendering the roles of the rows and columns symmetrical.

SYR.01:023

Syracuse U. [Dept. of Mathematics] N. Y.

DISCRETE POTENTIAL THEORY AND BOUNDARIES, by J. L. Doob. Sept. 1958, 37p. incl. refs. (Research rept. no. 19) (AFOSR-TN-58-884) [AF 18(600)760] AD 204102; PB 138126 Unclassified

Also published in Jour. Math. and Mech., v. 8: 433-458, May 1959.

The potential theory based on discrete parameter Markov processes is outlined and applied to obtain the Martin exit and entrance boundaries in the chains (countable state space) case. (Contractor's abstract)

SYR.01:024

Syracuse U. [Dept. of Mathematics] N. Y.

CONTINUOUS PARAMETER MARKOV CHAINS, by K. L. Chung. Sept. 1958 [13]p. incl. refs. (Research rept. no. 18) (AFOSR-TN-58-889) [AF 18(600)760] AD 204097 Unclassified

Also published in Proc. Internat'l. Congress of Mathematicians, Edinburgh (Gt. Brit.) (Aug. 14-21, 1958), London, Cambridge U. Press, 1960, p. 510-517.

Recent work on continuous parameter Markov chains was summarized with direct probabilistic methods. A few open problems are mentioned. (Contractor's abstract)

SYR.01:025

Syracuse U. [Dept. of Mathematics] N. Y.

NOTE ON DIFFERENTIATING MARKOFF TRANSITION FUNCTIONS WITH STABLE TERMINAL STATES, by D. G. Austin. [1958] [5]p. (AF 18(600)760) Unclassified

Published in Duke Math. Jour., v. 25: 625-629, Dec. 1958.

Given Markov transition probabilities $p_{ij}(t)$: $i, j = 1, 2, \dots$, $t \geq 0$, such that $p_{ij}(0) = 0$ ($i \neq j$) = 1 ($i = j$), Austin [Proc. Nat. Acad. Science, v. 41: 224-226, (1955)] proved that if $p_{ii}'(0) = \lim_{t \rightarrow 0} t^{-1}[p_{ii}(t) - 1] > -\infty$ (i.e.,

if i is stable), then for each j , $p_{ij}'(t) \in C[0, +\infty)$ and

$p_{ij}(t_1 + t_2) = \sum_k p_{ik}'(t_1)p_{kj}(t_2)$. He now proves that if j is stable, then for each i , $p_{ij}'(t) \in C[0, +\infty)$ and $p_{ij}'(t_1 + t_2) =$

$\sum_k p_{ik}(t_1)p_{kj}'(t_2)$. He also notes (at the suggestion of K. L. Chung) that $p_{ij}'(+\infty) = 0$ if either i or j is stable. (Math. Rev. abstract)

SYR.09:001

Syracuse U. [Dept. of Mathematics] N. Y.

ON SEMIGROUPS OF POSITIVE MATRICES, II, by W. B. Jurkat. Sept. 1958, 17p. incl. refs. (Research rept. no. 21) (AFOSR-TN-58-931) (AF 49(638)265) AD 205096; PB 138127 Unclassified

Also published in Scripta Math., v. 24: 207-218, Sept. 1959.

A discussion continues of the investigation of semi-groups of positive matrices $P(t) = p_{jk}(t)$ (item no. SYR.

09:002). Consideration is given to the sufficient conditions for the differential equations of Kolmogorov. The uniqueness and the existence of solutions to these equations are investigated, and some applications and higher order differential equations are discussed. Matrix algebra is employed, and inequalities, convergence, derivative, and integrals are defined component-wise.

SYR.09:002

Syracuse U. [Dept. of Mathematics] N. Y.

ON SEMI-GROUPS OF POSITIVE MATRICES, I, by W. B. Jurkat. Sept. 1958, 13p. incl. refs. (Research rept. no. 20) (AFOSR-TN-58-932) (AF 49(638)265) AD 205097 Unclassified

Also published in Scripta Math., v. 24: 123-131, June 1959.

An investigation is made of semi-groups of positive matrices $P(t) = [p_{jk}(t)]$ to point out that the properties of generalized Markov processes satisfying certain conditions (see item no. SYR.01:017) are true for ordinary Markov processes, even if the following properties are eliminated: (1) $\sum_k p_{jk}(t) \leq 1$, $j = 0, 1, \dots$, $t > 0$ and

(2) $\sum_k p_{jk}(t) = 1$, $j = 0, 1, \dots$, $t > 0$. The resulting theory developed attains a symmetric status since rows are not preferred any more, and the transposed matrix $P^*(t)$ also satisfies these conditions. Thereby, it is possible to complete the known results for ordinary Markov processes.

SYR.02:009; SYR.03:010, 011;
SYR.10:001, 002

SYR.02:009

Syracuse U. Dept. of Physics, N. Y.

[THEORY OF SOLIDS], by M. Lax. Final rept. Dec. 1957, 5p. (AFOSR-TR-58-13) (AF 18(600)651)
AD 148100 Unclassified

This contract originated in Feb. 1953 and terminated in Oct. 1957. A summary of the work on the contract is given including a list of eight reports which were in Vol. I. (See item nos. SYR.02:001-SYR.02:008)

SYR.03:010

Syracuse U. [Dept. of Physics] N. Y.

TWO-COMPONENT SPINORS IN GENERAL RELATIVITY (Abstract), by P. G. Bergman. [1957] [1]p. (AF 18(600)1124) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 240, Apr. 25, 1957.

Originally, H. Weyl related two-component spinors to a general Riemannian metric through quadrupoles, thus introducing local Lorentz transformations. As an alternative procedure, formulation is undertaken of the basic algebraic relationships in a direct covariant manner without reference to quadrupoles. In this formalism the groups of coordinate transformations in four-space and of unimodular transformations in the 2×2 spin space are unrelated to each other. It is possible to introduce spin-affine connections and, with their help, to construct a spin-curvature tensor. The latter is simply related to the usual Riemann-Christoffel tensor of Riemannian geometry.

SYR.03:011

Syracuse U. [Dept. of Physics] N. Y.

COLLISION PROCESSES IN GASES, by E. P. Gross. Final rept. [Dec. 23, 1957] 2p. (AFOSR-TR-58-15) (AF 18(600)1124) Unclassified

This contract was concerned principally with four topics: (1) boundary value problems in the theory of rarefied gases; (2) dynamics of ionized gases; (3) theory of dielectric and magnetic relaxation; and (4) electron lattice interactions. The results of these studies may be seen in Vol. I, item nos. SYR.03:001-SYR.03:009.

SYR.10:001

Syracuse U. [Dept. of Physics] N. Y.

ELECTRON SPIN-LATTICE RELAXATION IN PHOSPHORUS-DOPED SILICON, by A. Honig and E. Stupp. [1958] [2]p. incl. diagr. (AF 18(603)50) Unclassified

Published in Phys. Rev. Letters, v. 1: 275-276, Oct. 15, 1958.

The relaxation probability for a sample containing 1.4×10^{16} phosphorus atoms per cc was measured as a function of the magnetic field at 1.27°K and 2.06°K. Room temperature radiation was excluded so as to eliminate any contribution from photoelectrically excited conduction electrons, and the results are characteristic of phonon-produced interactions. The probabilities are several orders of magnitude larger than theoretical predictions.

SYR.10:002

Syracuse U. [Dept. of Physics] N. Y.

TRAPPING LIFETIME AND SPIN-LATTICE RELAXATION OF PHOTOEXCITED CONDUCTION ELECTRONS IN SILICON (Abstract), by A. Honig. [1958] [1]p. (AF 18(603)50) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago U., Ill., Nov. 28-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 377, Nov. 28, 1958.

The spins of electrons bound to the impurity atoms in nondegenerate n-silicon can relax to the Boltzmann distribution by means of electron exchange with the conduction electrons. At liquid helium temperatures, electrons can be excited into the conduction band with infrared radiation. By measuring the time for the bound spins to relax to the Boltzmann distribution as a function of the number of photons absorbed per sec per cm^3 , one can obtain the electron's lifetime against trapping, provided the conduction electron spin-lattice relaxation time, τ_{s-L} , is known. Such a determination of trapping lifetime was made, using for τ_{s-L} the value obtained from the line width in a degenerate phosphorus doped silicon sample. Recent experiments on nondegenerate phosphorus doped silicon samples of varying donor concentration and degree of compensation indicate that τ_{s-L} of the photoexcited electrons depends on the number of impurities and is considerably shorter than τ_{s-L} of electrons in low concentration degenerate samples. Using τ_{s-L} obtained from these experiments,

SYR.10:003; SYR.11:001;
SYR.12:001, 002

one finds trapping times shorter than those previously reported, and comparable to the lifetimes in germanium reported by Koenig.

SYR.12:001

Syracuse U. [Dept. of Psychology] N. Y.

STUDIES IN CONFORMITY BEHAVIOR, by F. J. DiVesta. Feb. 1, 1957 [38]p. incl. illus. tables, refs. (Technical note no. 1) (AFOSR-TN-57-138) (AF 18(603)-20) AD 120495
Unclassified

The effect of yielding of variables in the stimulus characteristics, the group characteristics, learning characteristics, and individual characteristics, was studied. Conformity, normative influence, or yielding were defined as the tendency of an individual to express judgments publicly which are in agreement with the expressed consensus of the group. An 80-item test was developed. Perceptual, attitudinal, and informational items were included. The test was shown to be reliable. Age was inversely related to susceptibility to normative influence. Females were more conforming than males. The persistency of the influence effect was inversely related to the length of time the subjects were exposed to group consensus without reinforcement. Among the group factors, the larger the group majority, the more influence it had on the modification of the individual's judgments. The presence of the stimulus and its influence on conformity were compared with that of responding from memory. No differential effects were found. The more ambiguous the situation, the more was the individual influenced by the decision of others. The individual's own habit hierarchy and his own perceptions were shown to affect the degree to which the individual was influenced by others. The degree to which individuals yield may be reduced under motivations where their personal needs may be threatened if performance is not satisfactory.

SYR.12:002

Syracuse U. [Dept. of Psychology] N. Y.

SUSCEPTIBILITY TO PRESSURES TOWARD UNIFORMITY OF BEHAVIOR IN SOCIAL SITUATIONS. A STUDY OF TASK, MOTIVATIONAL AND PERSONAL FACTORS IN CONFORMITY BEHAVIOR, by F. J. DiVesta. June 1958, 80p. incl. diagrs. tables, refs. (AFOSR-TR-58-70) (AF 18(603)20) AD 158291; PB 140461
Unclassified

A study was made of the effect of group structure variables on susceptibility to social influence. Three major classes of variables were of concern in the theoretical approaches: (1) the nature of the task of characteristics of the stimulus; (2) the extent of structure and cohesive qualities of the group; and (3) the personality patterns and dispositions of the individual that reflect his prior experience. The experiments and analyses were directed toward specifying a variable or variables under each major classification and demonstrating the conditions under which conformity occurs as a function of that variable. Results indicated that certain variables

SYR.10:003

Syracuse U. [Dept. of Physics] N. Y.

MEASUREMENT OF SPIN-SPIN RELAXATION TIME IN PHOSPHORUS-DOPED SILICON (Abstract), by A. Honig and E. Stupp. [1958] [1]p. [AF 18(603)50]
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 9, Jan. 29, 1958.

The electronic spin-lattice relaxation times are of the order of minutes for sufficiently dilute concentrations of phosphorus in silicon. Because of this isolation of the spin system from the lattice, it has been possible to investigate directly the kinetics of the spin-spin relaxation by a simple procedure. Abragam and Combrisson have shown that a partial spin temperature is established at a value of the magnetic field such that the Zeeman and hyperfine energies are equal. At this field value, a redistribution of the populations of the three lowest lying states can occur via the spin-spin interaction without any energy exchange with the lattice. By sweeping the magnetic field through this region at varying rates, and subsequently measuring the populations of the different hyperfine levels by microwave resonances, we obtained a measure of the spin-spin relaxation time. For a phosphorus concentration of $1.4 \times 10^{16}/\text{cm}^3$, about 1 second must be spent in passing over the line width to obtain half of the relaxation. In interpreting this result, it must be kept in mind that for a particular value of the external magnetic field, the spin packets that can interact to produce a spin temperature are restricted to those which do not require energy from the lattice.

SYR.11:001

Syracuse U. Dept. of Physics, N. Y.

WHISKER GROWTH FROM IODIDE TITANIUM WIRE, by A. M. Russell and R. C. Abbott. [1958] [2]p. incl. diagrs. [AF 49(C38)93]
Unclassified

Published in Jour. Appl. Phys., v. 29: 1130-1131, July 1958.

Ti wire heated in vacuum was subjected to temperature cycling between 800 and 1100°C at a rate of 6 c/min. Whiskers appeared after about 200 c, and were fully grown within a few cycles.

SYR.04:015 - SYR.04:019

may successfully operate to increase independence. On the other hand, none was influential in eliminating yielding entirely.

to find the expectation values unambiguously. Conversely quantum theory can be formulated in terms of such distribution functions having the prescribed properties.

SYR.04:015

Syracuse U. Inst. of Industrial Research, N. Y.

TWO-COMPONENT SPINORS IN GENERAL RELATIVITY, by P. G. Bergmann. May 1957, 19p. (Technical note no. P-9) (AFOSR-TN-57-259) (AF 18(600)459) AD 126557 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 240, Apr. 25, 1957.

Also published in Phys. Rev., v. 101: 624-629, July 15, 1957.

A general-relativistic theory is developed of two-component spinors somewhat along the lines pioneered more than twenty years ago by H. Weyl and by L. Infeld and B. L. van der Waerden. This formalism is in some respects more natural than the theory of four-component spinors. To begin a set of four 2×2 Hermitian matrices, σ^μ , are introduced into a four-dimensional manifold (the basic geometric structure used). It is shown that these matrices by themselves define uniquely a Riemannian metric with the usual signature of a space time manifold. It turns out that one can describe the gravitational field and its laws very conveniently in this matrix formalism; at the same time the σ^μ enable one to construct invariant two-component and four-component spinor wave equations. These formal possibilities are then used to define local Lorentz transformations and, in particular, the transformations corresponding to time reversal and to parity. (Contractor's abstract, modified)

SYR.04:016

Syracuse U. [Inst. of Industrial Research] N. Y.

DISTRIBUTION FUNCTIONS FOR NON-COMMUTING OPERATORS, by A. O. Barut. July 1957 [16]p. refs. (Technical note no. P-10) (AFOSR-TN-57-435) (AF 18(600)459) AD 136425 Unclassified

Also published in Phys. Rev., v. 108: 565-569, Nov. 1, 1957.

The properties of a certain class of functions $f(\alpha', \beta', \gamma')$ of non-commuting observables α, β, γ , are investigated. They have all the usual properties of distribution functions, except that they are complex. They satisfy simple Markoff-type stochastic equations and permit

SYR.04:017

Syracuse U. [Inst. of Industrial Research] N. Y.

QUANTUM MECHANICAL IRREVERSIBLE GIBBSIAN ENSEMBLES, by C. R. Willis and P. G. Bergmann. Oct. 1957, 37p. (Technical note no. P-11) (AFOSR-TN-57-623) (AF 18(600)459) AD 136611 Unclassified

A model of irreversible processes of Lebowitz and Bergmann is extended from the classical to the quantum mechanical domain. This model permits the construction of Gibbs-type ensemble for open systems not in equilibrium. The internal dynamics of the system that is engaged in a non-equilibrium process is assumed to be described fully by its Hamiltonian. Its interaction with its surroundings, i.e., the driving reservoirs, is described in terms of the weak, but sustained, interactions of perturbation theory. The reservoir consists of either free fermions or free bosons linearly or quadratically coupled to the system. The ensemble obeys an integral equation in configuration space, containing both the terms of the Liouville equation and a stochastic integral term that describes the interaction with the reservoir. It is shown for a restricted but important class of interactions that equilibrium is approached monotonically. (Contractor's abstract)

SYR.04:018

Syracuse U. [Inst. of Industrial Research] N. Y.

COVARIANT QUANTUM STATISTICS OF FIELDS, by A. O. Barut. Nov. 1957, 19p. (Technical note no. P-12) (AFOSR-TN-57-678) (AF 18(600)459) AD 136668 Unclassified

Also published in Phys. Rev., v. 109: 1376-1380, Feb. 15, 1958.

Relativistic formulas are derived for energy, momentum and number densities and distributions for systems of bosons and fermions from a covariant formulation of the statistics of fields. Charge, spin and angular momentum statistics are discussed. (Contractor's abstract)

SYR.04:019

Syracuse U. [Inst. of Industrial Research] N. Y.

OBSERVABLES IN SINGULAR THEORIES BY SYSTEMATIC APPROXIMATION, by E. Newman and P. G. Bergmann. [1957] [7]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)459] Office of Naval Research, and National Science Foundation) Unclassified

SYR.04:020 - SYR.04:023

Published in Rev. Modern Phys., v. 29: 443-449, July 1957.

In this paper an approximation procedure has been developed that purports to lead to the solution of the following purely abstract problem. Given a field yA of several parameters x , with an (infinitesimal) transformation law under a group of transformations whose elements depend on one or several arbitrary functions of the x ; find a complete set of functions (or functionals) of the $yA(x)$ that are invariant with respect to the transformation group.

cal model which resembles in certain aspects the above system is investigated. (Contractor's abstract, modified)

SYR.04:022

Syracuse U. [Inst. of Industrial Research] N. Y.

ON THE CONSTRUCTION OF A COMPLETE SET OF INDEPENDENT OBSERVABLES IN THE GENERAL THEORY OF RELATIVITY, by A. Komar. Apr. 1958, 20p. (Technical note no. P-13) (AFOSR-TN-58-276) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)459 and National Science Foundation) AD 154178 Unclassified

Also published in Phys. Rev., v. 111: 1182-1187, Aug. 15, 1958.

The construction of a complete set of quantities in general relativity, whose functional form is invariant under coordinate transformations, is indicated. The set obtained is highly redundant. The Cauchy problem for obtaining an independent complete set of observables is discussed. It is also pointed out, that the observables obtained may alternatively be viewed as the metric tensor in a special gauge, i.e., with a special coordinate condition. This latter viewpoint may readily facilitate the quantization of general relativity. (Contractor's abstract)

SYR.04:023

Syracuse U. [Inst. of Industrial Research] N. Y.

THE STRUCTURE OF PARTICLES IN LINEARIZED GRAVITATIONAL THEORY, by R. Sachs and P. G. Bergmann. Apr. 1958, 27p. incl. refs. (Technical note no. P-14) (AFOSR-TN-58-374) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)459 and National Science Foundation) AD 154281; PB 134758 Unclassified

Also published in Phys. Rev., v. 112: 674-680, Oct. 15, 1958.

The invariant character of restrictions imposed on singularities or other sources of the gravitational fields in the EIH theory of motion in General Relativity was examined. A complete classification of sources that can occur in the linearized theory only are provided, in terms of properties that are invariant under Lorentz and linearized curvilinear coordinate "gauge" transformations. Except for several explicitly known solutions, all solutions can be derived from a "supermetric" corresponding to the Hertz potential of electrodynamics. One method of classification is in terms of gauge-invariant integrals over spatial closed surfaces completely surrounding the particles. The motion of each source is determined by its own intrinsic angular

SYR.04:020

Syracuse U. [Inst. of Industrial Research] N. Y.

SUMMARY OF THE CHAPEL HILL CONFERENCE, by P. G. Bergmann. [1957] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)-459] and National Science Foundation) Unclassified

Published in Rev. Modern Phys., v. 29: 352-354, July 1957.

A summary of the relativity conference on the role of gravitation in physics which was held at the University of North Carolina in Jan. 1957 and a commentary on the three central headings of the conference papers are presented in terms of the accomplishments described in the several papers and the expectations of progress in each of these areas. The discussion is presented under two main headings: (1) the nonquantum theory of gravitation, and (2) the quantum theory of gravitation. A third topic, the theory of measurement, serves as a link between the other two.

SYR.04:021

Syracuse U. [Inst. of Industrial Research] N. Y.

MODEL OF A NONEQUILIBRIUM ENSEMBLE: THE KNUDSEN GAS, by J. L. Lebowitz and H. L. Frisch. [1958] 27p. (AFOSR-TN-58-266) (AF 18(600)459) AD 134845 Unclassified

Also published in Phys. Rev., v. 107: 917-923, Aug. 15, 1957.

An example of a nonequilibrium ensemble is constructed: a Knudsen gas in a container whose walls are maintained at different temperatures. The approach to a stationary state is investigated, and an iteration procedure for finding the stationary velocity distribution is derived. An explicit stationary solution is found for the case where a Knudsen thermal accommodation coefficient completely characterizes the effect of gas collisions with the walls. An expression for the rate of heat transfer from the wall is calculated. A stochastic mathemati-

SYR.04:024 - SYR.04:028

momentum and dipole moment. The results do not depend on any particular assumed form of the stress-energy tensor of the sources. (Contractor's abstract)

SYR.04:024

Syracuse U. [Inst. of Industrial Research] N. Y.

A THEORY OF PARTICLES OF SPIN ONE-HALF, by A. O. Barut. [1958] [11]p. [Technical note no. P-15] (AFOSR-TN-58-820) [AF 18(600)459] AD 222413
Unclassified

Also published in Ann. Phys., v. 5: 95-105, Oct. 1958.

From the two-component second order fermion theory of Feynman and Gell-Mann a four component theory of spin- $\frac{1}{2}$ particles in Hamiltonian form is derived. When a suitable indefinite metric is introduced in the spin space by means of charge density, the spin as well as the charge degrees of freedom may be separated. Spin and angular momentum are separately constants of the motion which is not the case for the Dirac equation. If states with positive norm describe particles, the states of the corresponding charge conjugate particles have negative norm. The Hamiltonian is quadratic in the momenta which allows a straightforward transition to the nonrelativistic Pauli equation. The law of transformation of the wave function under the Lorentz transformations is given, and the relation and equivalence of the theory to Dirac and Foldy-Wouthuysen equations is established. (Contractor's abstract)

SYR.04:025

Syracuse U. [Inst. of Industrial Research] N. Y.

COVARIANT CONSERVATION LAWS IN GENERAL RELATIVITY, by A. Komar. [1958] 7p. (AFOSR-TN-58-988) (AF 18(600)459) AD 205910
Unclassified

Also published in Phys. Rev., v. 113: 934-936, Feb. 1, 1959.

A set of covariant conservation laws is constructed in the general theory of relativity. Their relationship to the generators of infinitesimal coordinate transformations is indicated. In a given coordinate system certain of these quantities may be naturally identified as energy and momentum. (Contractor's abstract)

SYR.04:026

[Syracuse U. Inst. of Industrial Research, N. Y.]

THEORY OF IRREVERSIBLE PROCESSES, by P. G. Bergmann. Final rept. Oct. 1, 1952-Sept. 30, 1958, 4p. (AFOSR-TR-58-149) (AF 18(600)459) AD 222524
Unclassified

A summary of the results obtained under this contract is presented in the form of a list of technical reports, including journal references, and a list of personnel who have contributed to this work.

SYR.04:027

Syracuse U. [Inst. of Industrial Research] N. Y.

CONSTRUCTION OF OBSERVABLES IN GENERAL RELATIVITY (Abstract), by A. Komar. [1958] [1]p. [AF 18(600)459]
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 68, Jan. 29, 1958.

If the field equations of general relativity are satisfied, then one can construct at each world point exactly four

A^i as the roots of eigenvalue problems involving the curvature tensor. If these four scalars are algebraically independent of each other, they can serve as a uniquely defined (local) "canonical" coordinate system. The components of the corresponding canonical metric tensor are individually invariants; if they are given as functions of the four A^i , the Riemannian manifold is thereby uniquely characterized. Hence, these ten functions of four arguments represent a complete system of observables. This system is still highly redundant. In addition to the usual ten field equations, the components of the canonical metric tensor satisfy four additional differential equations, "coordinate conditions" that assure the canonical character of the coordinate system A^i . The Cauchy problem for these fourteen differential equations will be discussed. Its solution will yield a complete set of independent observables.

SYR.04:028

Syracuse U. [Inst. of Industrial Research] N. Y.

SUBSIDIARY CONDITIONS IN COVARIANT THEORIES, by P. G. Bergmann and A. I. Janis. [1958] [10]p. Incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)459], Office of Naval Research, and National Science Foundation) Unclassified

Published in Phys. Rev., v. 111: 1191-1200, Aug. 15, 1958.

We have investigated the effect that coordinate conditions and similar conditions will have on the formal properties of covariant theories. Two distinct types of coordinate conditions were included, those involving first derivatives of the field variables (such as the gauge condition of Lorentz and the coordinate conditions of De Donder) and those algebraic in the field variables (of which the

Coulomb gauge is an example). We have found that with either type of coordinate condition we can construct a variational principle, or a Hamiltonian formalism, which leads to physically meaningful field equations if associated with appropriate initial conditions on a space-like hypersurface. Thus the existence of a properly set Cauchy problem is always assured. It had been found previously that the infinitesimal invariant transformations of covariant theories form a group and the coordinate (and similar) transformations represent a normal subgroup. The members of the resulting factor group are in one-to-one correspondence with the true observables of the theory, those dynamical variables which alone possess intrinsic significance without reference to a particular frame of description and whose commutator algebra is presumably reflected in the commutators of the corresponding Hilbert operators of the quantized theory. In this paper we have established the appropriate transformation groups (and their subgroups and factor groups) of a theory with either type of coordinate conditions. We have found that in any of these versions the theory will yield the same observables with the same commutator algebra. One may therefore hope that a quantization scheme based on a theory with subsidiary conditions will be free of the arbitrariness involved in the choice of particular conditions. (Contractor's abstract)

SYR.07:002

Syracuse U. Research Inst. Electrical Engineering Dept., N. Y.

WAVE PROPAGATION IN NON-RECIPROCAL MEDIA, by R. F. Harrington. Final rept. Oct. 1958, 19p. incl. diagrs. table. (Rept. no. EE 368-5610F) (AFOSR-TR-58-151) (AF 18(600)1529) AD 222529 Unclassified

The problem of a non-reciprocal waveguide consisting of a thin axially-magnetized ferrite cylinder coaxially placed in a circular guide has received considerable attention because it is considered to be a useful geometry. Kales derived a characteristic equation for the determination of the propagation constants, but obtained no explicit solution or numerical values because of the complexity of the solution. Suhl and Walker have attacked the problem from a perturbation approach. It is proposed here that the exact characteristic equation be used to obtain approximate solutions. Compared to the perturbation approach, this has the inherent advantages of (a) allowing mathematical evaluation of the accuracy of solution, and (b) yielding exact answers if successive approximations are used.

SYR.13:001

Syracuse U. Research Inst. Electrical Engineering Dept., N. Y.

SYR.04:029

Syracuse U. [Inst. of Industrial Research] N. Y.

CONSERVATION LAWS IN GENERAL RELATIVITY AS THE GENERATORS OF COORDINATE TRANSFORMATIONS, by P. G. Bergmann. [1958] [3p. incl. refs. [AF 18(600)459] Unclassified

Published in Phys. Rev., v. 112: 287-289, Oct. 1, 1958.

The components of the so-called canonical energy-stress pseudotensor in general relativity may be thought of as the generators of infinitesimal coordinate transformations corresponding to a rigid parallel displacement of the coordinate origin, just as in Lorentz-covariant theories. In this paper it is shown that the canonical expressions, as well as the expressions proposed by Landau and Lifshitz and the expressions for the angular momentum density, are all special cases of an infinity of conservation laws whose pseudovectors generate arbitrary curvilinear coordinate transformations. This approach enables us to construct the transform of every one of these conservation laws under an arbitrary (finite) coordinate transformation. Finally it is shown that every one of these conservation laws may be used to obtain a surface integral relationship that describes the motion of singularities in a general-relativistic theory. It is concluded that there is an infinite number of parameters that describes a singularity of the field, a fact that had previously been in doubt. (Contractor's abstract)

FERROMAGNETIC RESONANCE IN MAGNETITE BELOW TRANSITION TEMPERATURE, by G. Herz, R. A. Johnson, and D. W. Healy, Jr. Final rept. June 1958, 38p. incl. diagrs. tables, refs. (Rept. no. EE472-587F) (AFOSR-TR-58-118) (AF 49(638)77) AD 201883; PB 137552 Unclassified

The conditions for electronic resonance in an orthorhombic magnetic crystal are examined and the relationship between ω and H required for resonance is predicted.

ed. In addition a calculation is made of the critical fields, H_c , above which the magnetization is aligned with applied field. Experimental verification of the relationship predicted between ω and H was attempted (for magnetite below its transition temperature) but is restricted to a narrow part of the total frequency and magnetic field spectrum needed for complete verification. The effect of pressure and a biasing magnetic field on the selection of the easy axis of magnetization are also examined as well as the role which magnetic dipolar forces may play in the observed anisotropy. (Contractor's abstract)

netite below its transition temperature) but is restricted to a narrow part of the total frequency and magnetic field spectrum needed for complete verification. The effect of pressure and a biasing magnetic field on the selection of the easy axis of magnetization are also examined as well as the role which magnetic dipolar forces may play in the observed anisotropy. (Contractor's abstract)

SYR.08:002 - SYR.08:005

SYR.08:002

Syracuse U. Research Inst. Mechanical Engineering
Dept., N. Y.

APPLICATION OF DONNELL-TYPE DYNAMIC EQUATIONS INCLUDING AND EXCLUDING THE EFFECTS OF TRANSVERSE SHEAR AND ROTATIONAL INERTIA TO VIBRATIONS OF INFINITELY LONG CYLINDRICAL SHELLS, by Y.-Y. Yu. July 1957, 1v. incl. diagrs. tables. (Rept. no. ME390-577TN2) (AFOSR-TN-57-390) (AF 18(603)5) AD 132465
Unclassified

Donnell-type dynamic equations of cylindrical shells have been obtained from Flugge's equations and from equations including the effects of transverse shear deformation and rotational inertia. In the present paper the latter equations are further given in such a form that the transverse shear and rotation effects may easily be suppressed; thus, two sets of equations which include and exclude these effects, respectively, and which are exact counterparts of each other were obtained. Equations excluding the transverse shear and rotation effects are found to be slightly different from the Donnell-type Flugge equations obtained previously. By means of the two sets of Donnell-type equations, including and excluding, respectively, the transverse shear and rotation effects, the free flexural vibration of infinitely long cylindrical shells and thus the propagation of flexural waves in such shells are then discussed. Expressions in compact form are derived for the frequency, modes, phase and group velocities, and numerical calculations have been carried out accordingly. (Contractor's abstract, modified)

SYR.08:003

Syracuse U. Research Inst. Mechanical Engineering
Dept., N. Y.

ON THE DONNELL EQUATIONS AND DONNELL-TYPE EQUATIONS OF THIN CYLINDRICAL SHELLS, by Y.-Y. Yu. Aug. 1957, 21p. refs. (Rept. no. ME390-578TN3) (AFOSR-TN-57-464) (AF 18(603)5) AD 136455
Unclassified

Also published in Proc. Third U. S. Nat'l. Congress of Appl. Mech., Brown U., Providence, R. I. (June 11-14, 1958), N. Y., Amer. Soc. Mech. Engineers, 1958, p. 479-487.

The Donnell equations of thin cylindrical shells are characterized by being in a completely uncoupled form, but they also involve simplifying assumptions concerning the strain expressions. Equations of thin cylindrical shells in such uncoupled form are called Donnell-type equations when no simplification of the strain expressions is involved in the derivation. A review of the previous results is first given on these equations, both static and dynamic, and either including or excluding the effects of transverse shear deformation and rotational inertia, together with their applications. A most

complete set of Donnell-type dynamic equations including the shear and rotation effects is then derived, which is shown to be reducible to the previous results. In particular, from this set of Donnell-type dynamic equations is deduced a set of Donnell dynamic equations, also including the shear and rotation effects. (Contractor's abstract)

SYR.08:004

Syracuse U. Research Inst. Mechanical Engineering
Dept., N. Y.

FREQUENCIES AND MODES OF FREE VIBRATIONS OF THIN CYLINDRICAL SHELLS HAVING FINITE LENGTHS, by Y.-Y. Yu. Final rept. Aug. 1957, 5p. (Rept. no. ME390-578TN4) (AF 18(603)5) Unclassified

This report summarizes previous research concerned with the free vibration of thin cylindrical shells in which the method of approach was through the use of Donnell and Donnell-type equations. A discussion is then presented of the vibration problems which have been solved by means of these equations.

SYR.08:005

Syracuse U. Research Inst. Mechanical Engineering
Dept., N. Y.

VIBRATIONS OF THIN CYLINDRICAL SHELLS ANALYZED BY MEANS OF DONNELL-TYPE EQUATIONS, by Y.-Y. Yu. [1958] 1v. incl. diagrs. refs. (AF 18(603)-5) Unclassified

Presented at Structures Session, Twenty-sixth annual meeting, Inst. Aeronaut. Sciences, New York, Jan. 27-30, 1958.

Published in Jour. Aero/Space Sciences, v. 25: 699-715, Nov. 1958.

The Donnell-type equations of thin cylindrical shells are characterized by being in a completely uncoupled form such that one equation of the set involves the radial displacement component w as the only dependent variable, and each of the remaining equations relates one of the other displacement components to w . Derivation is first given for Donnell-type dynamic equations including and excluding, respectively, the effects of transverse shear deformation and rotational inertia. The equations are then applied in a convenient and straightforward manner to the analysis of free vibrations of infinitely long cylindrical shells, with comprehensive results given for the frequency, modes, and phase and group velocities. Results on the frequency and modes are also immediately applicable to finite shells with simply supported edges. The cases of finite shells with clamped and flexibly supported edges are finally discussed by further making use of the Galerkin method in conjunction with the Donnell-type equations. (Contractor's abstract)

TOI.01:007 - TOI.01:010

TOI.01:007

Technical Operations, Inc., Arlington, Mass.

THE ZETA POTENTIAL OF SILVER BROMIDE IN THE PRESENCE OF VARIOUS SUBSTANCES OF PHOTOGRAPHIC INTEREST, by J. E. LuValle and J. M. Jackson. [1957] 33p. diagrs. tables, refs. (AFOSR-TN-57-144) (AF 18(600)371) AD 126433

Unclassified

Also published in Jour. Phys. Chem., v. 61: 1216-1222, Sept. 1957.

Also published in Science et Industries Photographiques, v. 29: 60, 1958.

The zeta potentials of silver bromide sols have been determined in the presence of some compounds commonly found in photographic processing solutions. It has been shown that conclusions regarding the zeta potential at the silver bromide surface are open to considerable question when gelatin, sensitizing dyes, quaternary salts, etc., are simultaneously present. The data clearly indicate the importance of adsorption processes in photographic development. The zeta potential-concentration curves (for different substances) are fitted

by a Langmuir adsorption isotherm $\theta = \frac{kc}{1+kc}$

where $k = 3 \times 10^8 \text{ cm}^{-3}/\text{mole}$ and $\theta = \frac{\zeta_1 - \zeta_m}{\zeta_0 - \zeta_m}$

where ζ_0 , ζ_1 and ζ_m are the zeta potentials in the absence of the adsorbed compound, the zeta potential at concentration c_1 of the adsorbed compound and the zeta potential when the surface is completely covered by adsorbed compound, respectively. (Contractor's abstract)

TOI.01:008

Technical Operations, Inc., Arlington, Mass.

MOLECULAR AFFINITY. I. DEVELOPMENT OF THE CONCEPT, by J. E. LuValle. July 1957, 1v. incl. diagrs. tables, refs. (Rept. no. TOI 57-18) (AFOSR-TN-57-554) (AF 18(600)371) AD 136538

Unclassified

A concept of molecular affinity, α , a measure of chemical reactivity based on the molecular ionization potential, I , and the molecular electron affinity, A , has been developed. $\alpha = I + A$. Molecular reactivity, ρ , has been defined as $\rho = \alpha \pm \lambda$ where $\lambda = \frac{A}{I}$ has been designated the localization affinity. The negative sign is

used when the molecule acts as an electron donor and the positive sign when the molecule acts as an electron acceptor. The molecular reactivity is the effective molecular affinity at the point of attack of the participating molecules. Hypotheses for the application of the concept have been postulated and a few examples treated.

A table of atomic affinities for the entire periodic system has been computed from atomic electronegativities for use in computing molecular affinities. The theoretical basis for this concept has been briefly discussed. (Contractor's abstract)

TOI.01:009

Technical Operations, Inc., Arlington, Mass.

MOLECULAR AFFINITY. II. CORRELATION WITH IONIZATION POTENTIALS, ELECTRON, SOLVENT, PROTON, NUCLEOPHILE AND RADICAL AFFINITIES AND RESONANCE ENERGY, by J. E. LuValle. July 1957, 1v. incl. diagrs. tables, refs. (Rept. no. TOI 57-19) (AFOSR-TN-57-555) (AF 18(600)371) AD 136539

Unclassified

The molecular affinity concept has been applied to the correlation of some physical properties. Molecular electron affinities have been computed from ionization potential data. Molecular electron affinities and energies of solution (solvent affinities) have been computed from ionization potential and polarographic half-wave potential data. Heats of hydration (water affinities) have been correlated with the differential molecular affinity, $\Delta\alpha$. Proton affinities have been correlated with differential molecular affinities, $\Delta\alpha$, and polarization (or localization affinities) energies deduced. Nucleophilic affinities have been correlated with molecular affinities. Radical affinities have been correlated with $\Delta\alpha$ and with differential molecular reactivities, $\Delta\rho$. It has been demonstrated that the localization affinity is inversely and linearly related to the quantum mechanical localization energy. The concept of resonance energy per atom constituting the molecule has been developed, and it has been shown that the molecular affinity of related compounds was linearly related to the resonance energy per atom, and that within any linear relationship, the molecular affinity minus the resonance energy per atom was a constant. (Contractor's abstract)

TOI.01:010

Technical Operations, Inc., Arlington, Mass.

MOLECULAR AFFINITY. IV. CORRELATION WITH CHEMICAL KINETIC DATA, by J. E. LuValle. July 1957, 1v. incl. diagrs. tables, refs. (Rept. no. TOI 57-21) (AFOSR-TN-57-556) (AF 18(600)371) AD 136540

Unclassified

The application of the molecular affinity concept to kinetic data has demonstrated that when the proper transition state has been chosen, the differential molecular affinity, $\Delta\alpha$, tends to be linearly related to the $\log k$ where k is the specific rate constant. The concept that $\Delta\omega = \Delta\alpha + \Delta F^\ddagger$ tends to be a constant for a given

TOI.01:011 - TOI.01:013

reaction, i.e., the reaction tends to be isoenergetic where $\Delta\omega$ is the total energy required for reaction, and ΔF^* is the free energy of reaction, has proven very useful in selecting the proper transition state. The hypothesis that the total energy of reaction, $\Delta\omega$, tends to be a minimum has supplemented the isoenergetic hypothesis in the choice of transition state. The correlation of kinetic data was best when reliable free energy of activation data were available. In some cases sufficient data were available so that steric effects could be computed. The data for some SN_2 reactions led to the conclusion that reaction proceeds by concerted attack of the entering group and at least two molecules of solvent. It also appeared probable that the molecule undergoing attack was solvated prior to reaction with the entering group and the two molecules of solvent. (Contractor's abstract)

TOI.01:011

Technical Operations, Inc., Arlington, Mass.

MOLECULAR AFFINITY. V. CORRELATION WITH CHEMICAL EQUILIBRIA DATA, by J. E. LuValle. July 1957, 1v. incl. diagrs. tables, refs. (Rept. no. TOI 57-22) (AFOSR-TN-57-557) (AF 18(600)371) AD 136541 Unclassified

Considerable data on equilibrium systems have been correlated by application of the molecular affinity concept. Data on the pK_a acids and bases showed that isoenergetic groupings were present. These data also led to the conclusion that the transition state for acid ionization must include the water equilibrium,

$H_3O^+ + OH^- \rightleftharpoons 2H_2O$. The data on keto-enol tautomerism of acetoacetic ester suggested that the extent of enolization increased as the molecular affinity of the solvent became different from that of the solute; i.e., as the acidity or basicity of the solvent increased relative to acetoacetic ester, the extent of enolization increased. Equilibrium data on charge transfer complexes and on the trimethylboron-amine complexes showed that the stability of the complexes were a function of $\Delta\omega$, where $\Delta\omega = \Delta F_{eq} + \Delta\sigma$. Polarographic half-wave data for some 4-amino-N-diethylanilines were used to establish isoenergetic groupings and to compute the steric strain for some 2-substituted N-alkyl anilines. The photographic and allergenic activities of these compounds were correlated with $\Delta\sigma$ and $\Delta\omega$. (Contractor's abstract)

TOI.01:012

Technical Operations, Inc., Arlington, Mass.

MOLECULAR AFFINITY. VI. CORRELATION WITH ORIENTING POWER OF SUBSTITUENTS AND WITH

THE HAMMETT SUBSTITUENT SIGMAS, by J. E. LuValle. July 1957, 1v. incl. diagrs. tables, refs. (Rept. no. TOI 57-23) (AFOSR-TN-57-558) (AF 18(600)371) AD 136542 Unclassified

It has been demonstrated that the orienting power of a substituent in monosubstituted benzenes for both electrophilic attack and phenyl radical attack may be correlated with the molecular affinity of the substituted molecule. It has also been shown that Hammett's σ , Taft's σ^* , σ_I , σ_R and E_S , Roberts and Moreland's σ' and Brown's σ_p^+ may be correlated with the molecular affinity of the substituted molecule or the substituent. It has been concluded that none of the sigmas represent just one effect. Hammett's σ , Taft's σ^* , and σ_I , Roberts and Moreland's σ' and Brown's σ_p^+ all contain resonance and steric effects as well as polar effects; Taft's σ_R contains polar and steric effects as well as resonance effects and Taft's steric substituent constant, E_S , contains polar and resonance effects as well as steric effects. Taft's σ^* , σ_I and σ_R do represent a considerable improvement over Hammett's σ and do show better correlation with molecular affinity computations than do Hammett's substituent sigmas. (Contractor's abstract)

TOI.01:013

Technical Operations, Inc., Arlington, Mass.

MOLECULAR AFFINITY. III. CORRELATION WITH DATA OBTAINED FROM THE INTERACTION OF ELECTROMAGNETIC RADIATION WITH MOLECULES, by J. E. LuValle. July 1957, 1v. incl. diagrs. tables, refs. (Rept. no. TOI 57-20) (AFOSR-TN-57-566) (AF 18(600)371) AD 136549 Unclassified

The correlation of molecular affinity computations with quadrupole coupling data and chemical shift data indicated that both sets of data are functions of the size, shape, steric relationships and intramolecular resonance energies. Furthermore, the data are also perturbed by media effects. Similar conclusions were reached in regard to diamagnetic susceptibility, molecular refraction and dipole moment data. Infra-red absorption spectra were correlated quite well with molecular affinity computations. However here again, the stereochemistry of the molecule and media effects were shown to perturb the absorption spectra. In the visible and uv spectra of condensed ring hydrocarbons, the assumption that the compounds donate electrons in the absorption process permitted computation of molecular reactivities which exhibited excellent linear correlation with the energy of the first absorption band. Molecular affinities and molecular reactivities were also correlated with reported charge transfer spectra. Where it was possible to compute molecular reactivities, the correlation was better than for molecular

TOI.01:014 - TOI.01:017

affinities. The data for the spectra of biacetyl appear to indicate an error in the ionization potential. (Contractor's abstract)

TOI.01:014

Technical Operations, Inc. [Arlington] Mass.

AN APPARATUS FOR THE INVESTIGATION OF RAPID REACTIONS. THE KINETICS OF THE CARBONIC ACID DEHYDRATION, by P. G. Scheurer, R. M. Brownell, and J. E. LuValle. Dec. 1957, 1v. incl. illus. diagrs. tables, refs. (Rept. no. TOI 57-34) (AFOSR-TN-57-787) (AF 18(600)371) AD 148018
Unclassified

Also published in Jour. Phys. Chem., v. 62: 809-812, July 1958.

A flow machine was constructed for the investigation of rapid reactions. An investigation of the dehydration of H_2CO_3 was made to determine the performance of the flow machine. Twenty-five ml of $2 \times 10^{-2} \text{M NaHCO}_3$ solution was mixed with 25 ml of $1.67 \times 10^{-2} \text{M HCl}$ in the flow machine. Each solution contained the same amount of $1.0 \times 10^{-4} \text{M}$ bromophenol blue indicator. A plot was made of pH vs time, and oscilloscopic traces were made of the H_2CO_3 dehydration. The energy of activation was found to be 16.1 kcal/mol, ΔS was 36 EU, and ΔF was 5.9 kcal/mol. First ionization constants and the heat of ionization were computed for H_2CO_3 at each temperature. The computed heats were in good agreement with Roughton's (Jour. Amer. Chem. Soc., v. 63: 2930, 1941) measured values. (ASTIA abstract)

TOI.01:015

Technical Operations, Inc., Arlington, Mass.

THE NATURE OF PHOTOGRAPHIC SENSITIVITY, by J. W. Mitchell. July 10, 1956 [34]p. incl. diagrs. refs. (AFOSR-TN-58-312) (AF 18(600)371) Unclassified

Also published in Proc. Internat'l. Conf. on Scient. Photography, Cologne (Germany) (Sept. 24-27, 1956), Darmstadt, Helvich Verlag, 1958, p. 29-35.

A general survey is presented of mechanisms of photographic sensitivity covering the wide field from nucleation of microcrystals to the formation of the visible image by development. Continuity is provided by the emphasis which is placed on the role of kink and edge sites on external and internal surfaces in all aspects of the photographic process. Among the topics discussed are: nucleation, growth, sensitivity centers, and chemical and optical sensitization of silver halide crystals; energy levels within and at the surface of silver bromo-

iodide crystals; the primary and secondary stages in the formation of the latent image; properties of the latent image; reciprocity failure and other latent image effects, observations on solarization, photolysis, and rehalogenation; and the nature of physical and chemical development.

TOI.01:016

Technical Operations, Inc., Arlington, Mass.

THE EFFECT OF SOLVENT AND SUBSTITUENTS ON THE ABSORPTION SPECTRUM OF QUINONE, by J. E. LuValle, G. M. Goldberg, and J. Des Roches. June 1958, 15p. incl. diagrs. table. (Rept. no. TOI 58-18) (AFOSR-TN-58-478) (AF 18(600)371) AD 158289; PB 135408
Unclassified

A linear correlation exists between $\Delta\alpha$, the difference in molecular affinities of the quinone and the solvent, and E_λ , the energy of the absorption band. In general, the frequency of the absorption band decreases as the value of $\Delta\alpha$ increases. The ionization potentials of the donor molecules are almost identical with donor molecule reactivity. This will be true whenever the electron affinity is small. The data show that chloranil forms 1:1 molecular complexes with both triethyl- and triphenylamine. The hexamethylbenzene chloranil complex was isolated and the infrared absorption spectrum obtained. The data lend strong support to the hypothesis that quinones in general tend to form complexes with Lewis bases. The linear relationships between molecular affinity and E_λ and the molecular reactivity and E_λ support the idea that the differential molecular affinity and the differential molecular reactivity are related to the interaction energy of acceptor and base. (Contractor's abstract)

TOI.01:017

Technical Operations, Inc., Arlington, Mass.

THE APPLICATION OF AN ANALOG COMPUTER TO THE ANALYSIS OF EXPERIMENTAL KINETIC DATA, by J. E. LuValle and H. Cornelius. June 15, 1958, 1v. incl. diagrs. table, refs. (Rept. no. TOI 58-19) (AFOSR-TN-58-527) (AF 18(600)371) AD 158341; PB 135576
Unclassified

The techniques of analysis of kinetic data are discussed. Practical limitations of these techniques as well as mathematical limitations on the handling of the differential equations involved are pointed out. The application of an analog computer to the analysis of some model reaction systems is illustrated. It is concluded that the widespread usage of concentration-extent of reaction and rate-extent of reaction curves would be of considerable benefit to investigations in chemical kinetics. These phase plots are much more sensitive to reaction complexity than are the usual concentration-time or integrated plots.

TOI.01:018 - TOI.01:020; TOI.02:003

TOI.01:018

Technical Operations, Inc., Arlington, Mass.

THE PHOTOGRAPHIC IMPLICATIONS OF THE CHEMISTRY OF QUINONE. FOG, ACCELERATED, CONTAGIOUS, INFECTIOUS AND SUPERADDITIVE DEVELOPMENT, LATENSIFICATION AND DESENSITIZATION, by J. E. LuValle and G. M. Goldberg. July 31, 1958, 21p. incl. tables, refs. (Rept. no. TOI 58-28) (AFOSR-TN-58-723) (AF 18(600)371) AD 162258

Unclassified

Also published in Jour. Photographic Science, v. 6: 176-184, Nov./Dec. 1958. (Title varies)

Data obtained in an investigation of the chemistry of quinone were used in conjunction with sensitometric data to relate fog with accelerated, contagious, infectious, and superadditive developments. Latensification and desensitization were studied. Experiments indicated that either hydroxyhydroquinone (I) or its precursors was the prime cause of fog in hydroquinone developing agents. The superadditive components of the developers Phenidone and Elon were found to be the best antifogants against I. Benzotriazole also appeared to react with I to form a nonfogging compound. Tests of the latensifying action of several free radicals indicated that Fremy's salt could be used to give reproducible latensification without aerial drying. Inhibition by the products of development in paraphenylenediamine developers was due to the destruction of latent image and small development centers by the semiquinone and the dimine of the paraphenylenediamine. Wurster's Blue and methylpyridinium iodine could desensitize exposed film. A dilute solution of Wurster's Blue could desensitize unexposed film.

TOI.01:019

Technical Operations, Inc., Arlington, Mass.

THE CHEMISTRY OF QUINONE, by J. E. LuValle, G. M. Goldberg and others. Aug. 15, 1958, 68p. incl. diagrs. tables, refs. (Rept. no. TOI 58-29) (AFOSR-TN-58-774) (AF 18(600)371) AD 201777

Unclassified

The chemistry of p-benzoquinone has been examined in detail. Of particular interest were the transitory colored intermediates observed in the early stages of some of the known reactions of quinone and the monomeric products thought to be formed on alkaline decomposition of quinone. Hydroxyhydroquinone, hydroxyquinone and 2,5-dihydroxyquinone were synthesized and their reactions were extensively investigated. It appears likely that a path of decomposition of quinone proceeds through the intermediates hydroxyhydroquinone, hydroxyquinone and dihydroxyhydroquinone to dihydroxyquinone. No evidence for the dismutation of quinone or hydroxyquinone was found. Observations on the behavior of

quinone in acid and alkaline solutions led to the formulation of two general mechanisms useful for the explanation of the reactions of quinone in solution. A series of ionic and free radical intermediates formed from quinone are capable of adding ions from solution to form the monomeric reaction products or of adding to other quinone molecules to form the polymeric humic acids. The extreme reactivity of quinone appears to arise as a result of the facile opening of its carbonyl bonds by either acidic or basic reagents. (Contractor's abstract)

TOI.01:020

Technical Operations, Inc., Arlington, Mass.

CHEMISTRY OF PHOTOGRAPHIC DEVELOPMENT, by J. E. LuValle and G. M. Goldberg. Final rept. Aug. 31, 1958 [30]p. incl. table. (Rept. no. TOI 58-30) (AFOSR-TR-58-112) (AF 18(600)371) AD 201772 Unclassified

A review is given of investigations into the mechanism of the photographic development process. The accomplishments achieved include: (1) the discovery that paper chromatography and paper electrophoresis can be useful in the identification and analysis of photographic developers; (2) the preparation of a bibliography on photographic theory on punched cards; (3) the finding that chemical processes are involved in the diffusion of developing agents in gelatin; (4) the determination of the zeta potential of AgBr in the presence of substances of photographic interest; (5) knowledge of the chemistry of quinone; (6) the identification of the source of development fog in photographic processes as hydroxyhydroquinone; (7) the construction of a flow machine for the investigation of rapid reactions and the dehydration of H_2CO_3 used to test it; (8) the application of an analog computer to the analysis of kinetic data; (9) the development of ideas on the nature of the interaction between molecules; (10) the discovery that AgBr can take at least 40,000 r of radiation without formation of appreciable fog; and (11) the formation of the hypothesis that good chemical developers must contain or have the potential of forming a structure in which the active substituents are arranged, in relation to each other, in a similar manner to those of hydroxyhydroquinone or amidol.

TOI.02:003

Technical Operations, Inc., Arlington, Mass.

FLUORESCENCE OF NAPHTHALENE AND ANTHRACENE VAPORS UNDER β -RAY EXCITATION, by A. Shepp. [1957] [5]p. incl. illus. table, refs. (AFOSR-TN-57-431) (AF 18(600)1134) AD 136420

Unclassified

Also published in Jour. Chem. Phys., v. 27: 816-817, Sept. 1957.

TOI.02:004; TOI.03:001;
TRG.02:002, 003

The fluorescence intensities of anthracene and naphthalene vapors, and a mixture of these, excited by the β -radiation from tritium gas, were measured by a photomultiplier, through filters. An analysis of the results shows them to be consistent with absorption by anthracene of the naphthalene 3500A fluorescence. There is no evidence for photon emission from the third naphthalene band (2500A). The tritium-activated fluorescence spectrum of anthracene vapor has been observed, extending from 3900A to 4500A. There is no evidence of emission from the second anthracene band at 3500A.

TOI.02:004

Technical Operations, Inc., Arlington, Mass.

QUALITATIVE CONVERSION BY PHOSPHORS OF THE ENERGY OF BETA PARTICLES INTO FLUORESCENT QUANTA, by A. Shepp. Final rept. Apr. 1958, 67p. incl. diagrs. tables, refs. (Rept. no. TOI 58-12) (AFOSR-TR-58-56) (AF 18(600)1134) AD 154270 Unclassified

This final report is divided into three sections. Section I is an extensively detailed report on the method and results for the absolute fluorescence energy efficiency and the practical fluorescence energy efficiency of a crystal of anthracene, at room temperature, under excitation of Sr^{90} β -ray. The results are 33% for the absolute energy efficiency, and 2.2% for the practical efficiency. Section II is a moderately detailed report concerning work on the vapor phase fluorescence of anthracene and naphthalene under tritium (T^3) β -ray excitation, in which it is shown that fluorescence directly from upper excited states does not occur. Section III briefly reviews work on inorganic phosphors, purification techniques, and plastic scintillators.

TOI.03:001

Technical Operations, Inc., [Arlington] Mass.

SYNTHESIS AND TESTING OF NEW HETEROCYCLIC PHOTOGRAPHIC DEVELOPING AGENTS, by G. M. Goldberg and J. E. LuValle. Final rept. May 1957, 64p. incl. diagrs. tables, refs. (Rept. no. TOI 57-12) (AFOSR-TR-57-29) (AF 18(600)1569) AD 126464 Unclassified

The material contained in this report is a detailed summary of work carried out between Oct. 1, 1955 and Dec. 31, 1956 on the synthesis and photographic testing of various heterocyclic compounds which were regarded as potential developing agents. A survey of the patent literature for the years 1937 to 1955 was conducted to determine the areas in which work had already been done. Following this, suitably substituted heterocyclic compounds, obtained by purchase or by synthesis, were tested as photographic developers. A detailed descrip-

tion of the synthetic procedures used is included in this report as well as all data obtained in the photographic testing program. Several heterocyclic compounds containing or capable of reacting to form the structure thought to be responsible for good developing action were found to be photographically active. The only heterocyclic compound showing practical developing activity was 2, 3, 6-triaminopyridine. Extensive testing of this compound indicated it was at least as active as hydroquinone. A patent application covering this compound will be filed. A short summary of the sensitometric data concerning 2, 3, 6-triaminopyridine (TAP) is included in this report. (Contractor's abstract)

TRG.02:002

Technical Research Group, New York.

STEADY STATE SIGNAL IN THE PRESENCE OF "SHIMMING" PULSES, by B. Nelson. Feb. 13, 1957, 22p. incl. diagrs. (AFOSR-TN-57-72) (AF 18(600)1313) AD 120415; PB 127159 Unclassified

A number of explanations are discussed of the theoretical and actual possibility of the construction of filters at

radio frequencies with Q of the order of 10^6 and with no insertion loss, using nuclear magnetic resonance lines obtainable in homogeneous magnetic fields. Interaction of nuclear spins with the lattice and spin-spin interaction are covered, in addition to a mention and critique of other parameters.

TRG.02:003

Technical Research Group, New York.

A TRAVELING WAVE GAS CELL MASER, by M. Newstein and R. T. Daly. Feb. 27, 1957 [27]p. incl. diagrs. table, refs. (AFOSR-TN-57-111) (AF 18(600)-1313) AD 120464 Unclassified

An apparatus is described which will amplify an incident RF wave by causing the signal to pass through a substance in a nonequilibrium thermodynamic state and stimulate it into radiating coherently at the same frequency. The name, Maser, an acronym for microwave amplification by stimulated emission of radiation is applied to the device. The operation of the apparatus is based on increasing the population of an excited state over the ground state in a particular transition in a certain volume of the maser cell. The RF signal to be amplified is localized to that region of the cell containing an excess of the excited state. In motivating the design of the apparatus, the transition between the inversion levels of the 3-3 level of NH_3 is considered. Calculations show the possibility of constructing a traveling-wave gas-cell maser. The question of the feasibility of its operation with a particular gain is reduced to the question of whether sufficiently strong electric fields can be produced without

TRG.02:004; TIH.03:001, 002;
TIH.04:001; TEA.01:001

breakdown. Fields of the order of 1.4×10^5 v/in. are required in order for the device to barely amplify at room temperature. At 130°K, the field required for zero gain is about 0.6×10^5 v/in. For a gain of 2.6×10^{-2} db/cm, a field of 2×10^5 v/in. would be required.

TRG.02:004

Technical Research Group, New York.

SPURIOUS SIGNAL GENERATED BY "SHIMMING" PULSES, by M. Newstein. Apr. 1958, 27p. incl. illus. diags. (AFOSR-TN-57-612) (AF 18(600)1313) AD 136602 Unclassified

Further investigation was conducted on the spurious signal generated by shimming pulses. In previous discussions of the reclustering experiment, each one of the shimming pulses was represented by a matrix which rotated each element of the spin spectrum by precisely 180° about the direction of the applied magnetic field. The pulses that are actually applied to the spin system differ from the idealized pulses in several respects. The effect of two of these differences is discussed. Expressions are derived for spurious signal amplitude and the transverse magnetization after a string of pulses. (ASTIA abstract)

TIH.03:001

Technion - Israel Inst. of Tech., Haifa.

FURTHER RESEARCH ON THE PHYSICS OF AIR VISCOSITY. CROSS STRESSES IN THE LAMINAR FLOW OF GASES, by J. Crane, B. Popper, and M. Reiner. Research progress rept. July 15, 1956-Feb. 14, 1957, 4p. diags. (AFOSR-TN-57-189) (AF 61(514)964) AD 126484 Unclassified

Cross stresses in the laminar flow of gases are studied. An instrument is described which works as a centripetal vacuum pump. The suction for different gases as functions of the rotational velocity are recorded. It is shown that the effect increases with the complexity of the molecule.

TIH.03:002

Technion - Israel Inst. of Tech., Haifa.

FURTHER RESEARCH ON THE PHYSICS OF AIR VISCOSITY, by M. Reiner. Research progress summary rept. Feb. 15-Sept. 30, 1957, 1v. incl. illus. diags. tables. (AFOSR-TN-58-454) (AF 61(514)964) AD 158261 Unclassified

A history is given of the first centripetal air-pressure pump. The problem was to enable the rotor to rotate

at high speeds with the smallest amplitude of longitudinal vibrations when the rotor-stator gap was extremely small and the speed was high. An instrument is described which consists of 2 circular metal plates, one stationary, and the other rotating opposite it, with a very narrow adjustable gap between them. In the center of the stationary plate a manometer is attached at an opening. The manometer registers pressures increasing with the speed of rotation and decreasing with increasing width of gap. At 15u the pressure disappears, and at larger gaps it becomes a suction. Another instrument that works as a centripetal vacuum pump is described which consists of 2 circular plates similar to the ones mentioned. Observations were made with speeds of rotation of 1000 to 13,000 rpm and 2 different loads from rotor. Second-order effects in infinitesimal elasticity were examined theoretically for different measures of strain and 2 cases of torsion of a right circular cylinder with free and prevented extension.

TIH.04:001

Technion - Israel Inst. of Tech., Haifa.

THE CENTRIPETAL-PUMP EFFECT IN A VACUUM PUMP, by M. Reiner. [1958] [16]p. incl. diags. tables, refs. (AF 61(052)10) Unclassified

Published in Proc. Royal Soc. (London), v. 247A: 152-167, Sept. 16, 1958.

An instrument is described which works as a centripetal vacuum pump. It consists of two circular metal plates, one stationary, the other rotating opposite it. The stator has an opening in the center. The rotor can be freely displaced along the axis of rotation. By centripetal pumping action it is kept floating on an air cushion of thickness D. The relation between D and the speed of rotation was determined for different weights of the rotor to be supported. The results are interpreted on the basis of Maxwell's theory of the elastico-viscosity of air. (Contractor's abstract)

TEA.01:001

Technische Hochschule. Institut für Mechanik, Aachen (Germany).

MEASUREMENTS OF THE BOUNDARY LAYER THICKNESS AND RELAXATION OF IONIZATION BEHIND STRONG SHOCK WAVES WITH A NEW CAPACITIVE PROBE, by H. Groenig and H. D. Weymann. Feb. 1958 [22]p. incl. illus. diags. (Technical note no. 1) (In cooperation with Maryland U. Inst. for Fluid Dynamics and Applied Mathematics) (AFOSR-TN-58-387) (AF 61- (514)1046) AD 154294 Unclassified

This report deals with the measurements of the thickness of the boundary layer with a capacity probe. This probe flush inserted into the wall of the shock tube and

THB.01:002; THB.04:005;
THB.06:001, 002

thus avoiding any disturbances in the flow is sensitive to the thickness of the boundary layer, when the gas in the undisturbed flow is ionized. The experimental results for argon at Mach numbers between 5 and 10 show the usefulness of the probe for measuring the thickness of the boundary layer, the relaxation time of ionization and the coefficient of diffusion. The experiments were carried out in argon because high Mach numbers could be achieved in argon even with a small shock tube. (Contractor's abstract)

THB.01:002

Technische Hochschule. Institut für Strömungsmechanik, Braunschweig (Germany).

THEORETICAL AND EXPERIMENTAL INVESTIGATIONS ON SWEEPED AND DELTA WINGS IN INCOMPRESSIBLE FLOW, by E. Trukenbrodt. Mar. 23, 1954, 6p. incl. diagrs. (AFOSR-TN-54-95) (AF 61(514)426) AD 35724
Unclassified

A summary is presented of the experimental results and theoretical predictions of the influence of the aspect ratio on the aerodynamic parameters of swept and delta wings in symmetrical flow. Three component measurements were carried out on five delta and five swept wings with profile NACA 0012, zero twist, constant chord and constant sweep angle ($\alpha = 45^\circ$) for the swept wings, and constant taper ratio 1:8 for the delta wings. Agreement with theories prepared by the authors for extended lifting lines and lifting surfaces is very good in all cases.

THB.04:005

Technische Hochschule. Institut für Strömungsmechanik, Braunschweig (Germany).

SYSTEMATIC INVESTIGATIONS ON SECONDARY FLOW LOSSES IN CASCADES, by N. Scholz. Mar. 27, 1957, 62p. incl. illus. diagrs. tables. refs. (Rept. no. 56/18a) (AFOSR-TR-57-39) (AF 61(514)650-C)
AD 132400
Unclassified

An extensive program on experimental investigations of secondary flow losses in cascades have been carried out. These investigations are an extension of previous measurements on two-dimensional cascades. The scope and kind of the present measurements is outlined and the evaluation is discussed. The program includes secondary flow effects at blade tip and blade foot for turbine and compressor cascades. The blade section is NACA 8410. There are no fillets at the blade foot, and the blade tip is cut off bluntly. The solidity ratio, the blade angle, and the angle of inflow of the cascade have been varied. The losses of the cascades have been obtained from wake surveys in a plane behind the cascade. The distribution of local values of the losses over the blade length and the blade distance is given. From these averaged values have been obtained by integration. The

very comprehensive results have a good insight about the magnitude of the secondary flow losses, and how they depend on the cascade geometry.

THB.06:001

Technische Hochschule. Institut für Strömungsmechanik, Braunschweig (Germany).

PRESSURE DISTRIBUTION MEASUREMENTS ON TWO-DIMENSIONAL CASCADES AT HIGH SUBSONIC MACH NUMBERS. PART I, by K. H. Grewe. Mar. 12, 1957, 47p. incl. diagrs. tables. (Rept. no. 57/6a) (AFOSR-TN-57-289) (AF 61(514)934) AD 132360
Unclassified

A selection of the first measurements in the new High Speed Cascade Wind Tunnel of the Deutsche Forschungsanstalt für Luftfahrt (DFL) is presented. They concern pressure distribution measurements on two-dimensional cascades with blade sections NACA 0010 and NACA 8410, with variation of solidity ratio, blade angle, and angle of inflow. Extending previous measurements in incompressible flow the influence of the Mach number on the pressure distribution of the cascade blades has been investigated. The measurements cover the subsonic Mach number range up to the choking number. The Reynolds number was constant, throughout, $Re_1 = 3 \times 10^5$. The results show that up

to those Mach numbers, where the velocity of sound is reached locally at the blade surface (critical Mach number), the pressure distribution over the blade surface is determined by the nonviscous subsonic flow through the cascade. At higher Mach numbers, however, up to the choking Mach number, the pressure distribution is influenced very much by shock waves.

THB.06:002

[Technische Hochschule. Inst. für Strömungsmechanik, Braunschweig (Germany)].

[PRESSURE DISTRIBUTION] MEASUREMENTS ON TWO-DIMENSIONAL CASCADES AT HIGH SUBSONIC MACH NUMBERS. PART II. MEASUREMENTS OF LOSS COEFFICIENTS, by U. Hopkes. Jan. 28, 1958, 25p. incl. diagrs. tables. (Rept. no. 47/23a) (AFOSR-TN-57-289a) (AF 61(514)934) AD 203031
Unclassified

Some preliminary results of measurements of loss coefficients for cascades with profiles NACA 0010 and NACA 8410 at high subsonic Mach numbers are given. These measurements were done by wake-surveys varying independently the Reynolds number and the Mach number. Fully turbulent flow was obtained in all cases by turbulence wires on the blades. At low Mach numbers the loss coefficients vary with the Reynolds number according to the $Re^{-1/5}$ -law of incompressible flow. The loss coefficients increase considerably, when approaching the choking Mach number. (ASTIA abstract)

THB.07:001; TEK.01:001, 002; TEK.02:001;
THM.01:001

THB.07:001

Technische Hochschule. Inst. für Strömungsmechanik,
Braunschweig (Germany).

INVESTIGATIONS ON THE STALLING CHARACTER-
ISTICS OF DELTA WINGS IN INCOMPRESSIBLE FLOW,
by E. Truckenbrodt and E. G. Feindt. Final rept. June
4, 1957, 46p. incl. diagrs. tables. (Rept. no. 57/11a)
(AFOSR-TN-57-538) (AF 61(514)935) AD 136524;
PB 132349 Unclassified

Also published in Zeitschr. Flugwissensch., v. 6: 97-
102, Apr. 1958.

The stalling characteristics of Delta wing plan-forms in
symmetrical flow have been investigated for Reynolds
numbers up to $Re = 1, 7 \times 10^6$ in incompressible flow.
Four of these Delta wings with different aspect ratios
have wing section NACA 0012 and one has NACA 0005.
The critical angle of incidence at which separation be-
gins has been determined from wake measurements
according to a method due to X. Hafer. Thus the span-
wise distribution of the critical angle of incidence was
obtained, and also the vertical position of the maximum
loss in total head in the wake. For the Delta wings
with small aspect ratio separation begins for higher
angles of incidence than for Delta wings with large as-
pect ratio. The wing plan forms with the 12% thick pro-
file have a smaller tendency for separation than the
wing plan-form with a 5% thick profile. For all wing
plan-forms investigated separation starts at the wing
tip and with increasing angle of incidence proceeds to
the root. In all cases the separation phenomena are
symmetrical on the two halves of the wing plan-form.
The results of the measurements of the critical angle
of incidence are compared with pressure distribution
measurements. (Contractor's abstract, modified)

TEK.01:001

Technische Hochschule. Institut für Angewandte
Mathematik, Karlsruhe (Germany).

THE RING AIRFOIL WITH DEFLECTED CONTROL
SURFACE IN STEADY INCOMPRESSIBLE FLOW, by
J. Weissinger. Jan. 1957, 19p. diagrs. tables.
(AFOSR-TR-57-8, Pt. I) (AF 61(514)904) AD 115097
Unclassified

A brief review of an earlier report by this author
(Zeitschr. Flugwissensch., v. 4: 141-150, 1956) is
given and numerical material was added. The general
reciprocity theorem of wing theory in the special form
for ring airfoils in steady incompressible flow is used
in deriving formulas for the distribution of radial force
and pitching moment along the circumference and for
the total lift and pitching moment caused by the deflec-
tion of a control surface. The numerical results show

a strong influence of ring shape (characterized by the
length-diameter ratio $\lambda = L/D$) on the effectiveness of
the control surface. (Contractor's abstract, modified)

TEK.01:002

Technische Hochschule. Institut für Angewandte
Mathematik, Karlsruhe (Germany).

THE INFLUENCE OF PROFILE THICKNESS ON RING
AIRFOILS IN STEADY INCOMPRESSIBLE FLOW, by
J. Weissinger. Jan. 1957, 43p. diagrs. tables. (AFOSR-
TR-57-8, Pt. II) (AF 61(514)904) AD 120424
Unclassified

In order to produce profile thickness for ring airfoils -
contrary to two-dimensional theory - not only a source
distribution is needed, but also a vortex distribution.
This vortex distribution is determined by an integral
equation the kernel of which has been tabulated. The
axial velocity at a cylinder covered with sources and
vortices in such a way as to produce ring airfoils is
given in a form suitable for practical computation;
these formulas have an explicit term and a second term,
which must be calculated by numerical quadrature us-
ing tabulated kernel functions, in most cases however,
this second term can be neglected because of its small-
ness. The values of these integrals have been tabulated
for the most interesting cases so that for actual compu-
tations only a superposition of explicit and tabulated
terms is necessary. Finally it is shown how from these
velocities at the circular cylinder the velocity at the
profile may be calculated.

TEK.02:001

Technische Hochschule. Institut für Angewandte
Mathematik, Karlsruhe (Germany).

REMARKS ON RING AIRFOIL THEORY, by J.
Weissinger. Jan. 1958 [86]p. incl. diagrs. tables, refs.
(AFOSR-TN-58-224) (AF 61(514)1207) AD 154127
Unclassified

An investigation was conducted on ring airfoils in (in-
compressible) potential flow. The circumferential ve-
locity at the ring surface was calculated for application
to the 3-dimensional boundary layer calculations and for
stress analysis. Pitching moments of ring airfoils were
also calculated. The influence of a central body on pres-
sure distribution, lift and pitching moment was investi-
gated. Boundary layer effects were studied, in particu-
lar drag and separation.

THM.01:001

[Technische Hochschule. Physikalisches Inst., Munich
(Germany).]

MAGNETIC PROPERTIES OF RARE EARTH METALS

THM.01:002; THM.02:001; THM.03:001

AT VERY LOW TEMPERATURES. MAGNETIC SUSCEPTIBILITY OF METALLIC NEODYMIUM IN THE TEMPERATURE RANGE BETWEEN 1.5 AND 300°K, by H. Leipfinger. May 1-Oct. 31, 1956 [14]p. incl. illus. diagrs. table, refs. (AFOSR-TN-57-4) (AF 61-514)94;) AD 115034 Unclassified

The magnetic susceptibility of metallic neodymium was measured in the intervals 1.74°K - 4.17°K, 14.2°K - 20.2°K, 66.0°K - 76.9°K and at 90°K, 199°K, 293°K. It was established, that over 14.2°K the metal obeys the Curie-Weiss-law with a Curie-temperature of -0.16°K and an effective moment of 3.58 magnetons. (Theoretical value of the free Nd^{+++} ion at low temperatures 3.62). At liquid helium temperatures the susceptibility decreases with decreasing temperatures. Therefore neodymium metal is antiferromagnetic at these temperatures. The Neel-point lies in the range between 4.17°K and 14.2°K, which cannot be covered with the usual cryostatic methods. Its value is about 6.5°K. (Contractor's abstract)

THM.01:002

Technische Hochschule. Physikalisches Inst., Munich (Germany).

MAGNETIC PROPERTIES OF RARE EARTH METALS AT VERY LOW TEMPERATURES, by H. Leipfinger. May 1, 1956-July 31, 1957, 40p. incl. diagrs. tables, refs. (AFOSR-TN-57-561) (AF 61(514)941) AD 136546 Unclassified

The magnetic susceptibilities of the rare earth metals Ce, Pr, Nd, Sm, Dy, Yb were measured from 293°K down to 1.5°K. With the exception of Yb and possibly Eu(not yet measured) the ions, which constitute the lattice of the metal, are the same as the salts or oxides. Yb is built up foremost by divalent ions. The small magnetism allows not more than 2% Yb^{3+} -ions and even this magnetism can be caused by impurities. In the salts the deviations from the Curie-law are caused by crystal field splitting of the electronic terms, in metals this splitting is, if it exists at all, weak, whilst exchange coupling brings in most cases either antiferromagnetism or ferromagnetism. Together with the measurements of other metals not yet finished, one can guess the rule, that at very low temperatures the metals of the first half, Ce-Eu, are antiferromagnetic, and the metals of the second half, ferromagnetic. No coupling effects were observed in Pr and Yb, the latter being built up by divalent ions. (Contractor's abstract)

THM.02:001

Technische Hochschule. Physikalisches Inst., Munich (Germany).

CONNECTION BETWEEN SILVER BROMIDE GRAINS

AND THE SENSITIVITY OF THE EMULSIONS, by W. Waidelich. Technical rept. May 1, 1956-Sept. 30, 1957. Oct. 1, 1957, 33p. incl. diagrs. tables, refs. (AFOSR-TR-57-75) (AF 61(514)942) AD 136637 Unclassified

By precision-measurements of the half-breadth of the Debye fringes of photographic grains the sizes of the coherent lattice domains were determined. There is a connection between domain size and sensitivity; the higher the speed, the smaller the domain. Since there are other influences, e.g., the size of the grains, the connection is merely a stochastic one, if one compares all emulsions together, but by comparing similar emulsions one gets nearly smooth curves with a small scattering of the points. It is concluded from the results, that the internal image is formed mainly at "inner surfaces", i.e., the boundaries of the coherent domains. This can be interpreted in this way, that in the inner part of an undisturbed AgBr lattice there is no place for a growing center. By separated development of the internal and the surface image it could be shown that the number of internal development centers is higher the more internal surfaces are present.

THM.03:001

Technische Hochschule. [Physikalisches Inst.] Munich (Germany).

SUPERSONIC FLOW PAST SLENDER BODIES OF ARBITRARY SHAPE (PRACTICAL NUMERICAL METHODS FOR ELECTRONIC COMPUTERS), by R. Sauer. [1957] 15p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-57-162) (AF 61(514)1080) AD 126454 Unclassified

The linearized supersonic steady flow around slender bodies of arbitrary shape is discussed. The velocity potential is developed into a Fourier series. The coefficients of the Fourier series are finite or infinite sums of Legendre functions of the second kind. The terms of the Fourier series correspond to singularities distributed along the axis of the body. The two first terms give the well known solution of von Kármán, Moore, and Tsien for bodies of revolution with zero or small angle of attack. The following terms characterize deformations of the body of revolution and in this way one obtains a flow past "slender bodies of arbitrary shape". Considering only the first terms of the sums of Legendre functions, one gets conical flow fields. As an example, the flow past a delta wing with elliptic cross section is discussed. Next, the flow past a slender body of arbitrary shape is approximated by superposition of conical flow fields along the axis. In this way a practical numerical method results for the calculation of the flow around arbitrary slender bodies by solving a system of algebraic linear equations. The most important application of this method is the wing body interference since a wing body combination is a "slender body of arbitrary shape".

THM.03:002 - THM.03:006

The practical numerical work that is to be done will be performed by use of the Electronic Computer "PERM" of the Technische Hochschule, Munich (Germany). (Contractor's abstract)

THM.03:002

Technische Hochschule. [Physikalisches Inst.] Munich (Germany).

CALCULATION OF SUPERSONIC FLOW PAST SLOWLY OSCILLATING BODIES OF REVOLUTION BY USE OF ELECTRONIC COMPUTERS, by J. Muench. [1957] 21p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-57-673) (AF 61(514)1080) AD 136662 Unclassified

The linearized supersonic flow around slowly oscillating bodies of revolution as determined by means of electronic computers is discussed. The calculation of surface pressure and of the quasisteady and unsteady aerodynamic coefficients is reduced to matrix operations. The procedure deals with triangular matrices, the elements of which are hyperbolic cosines or square roots, or their linear combinations.

THM.03:003

Technische Hochschule. [Physikalisches Inst.] Munich (Germany).

SUPERSONIC FLOW AROUND QUASI-CONICAL BODIES, WITH APPLICATION TO WING-BODY INTERFERENCE, by H. J. Stetter. [1958] 24p. incl. diagrs. (Technical note no. 3) (AFOSR-TN-58-167) (AF 61(514)1080) AD 152194 Unclassified

A theory was developed for the computation of the linearized supersonic flow field around a quasi-conical body. The disturbance potential and its derivatives are gained from the boundary condition either by the use of characteristic functions or by reduction to the quasi-cylindrical problem (involving the solution of an integral equation). The theory permits not only the computation of the flow field around a slightly bumped or indented circular cone, but also the solution of the wing-body interference problem for a circular conical body with wings with supersonic leading edges. No practical numerical work was performed, but use of the Munich electronic computer is proposed.

THM.03:004

Technische Hochschule. [Physikalisches Inst.] Munich (Germany).

ON THE VALIDITY OF THE "THEOREM OF EQUIVALENCE" AND THE AREA-RULE IN SUPERSONIC FLOW,

by W. Werner. Mar. 28, 1958 [26]p. incl. diagrs. tables. (Technical note no. 4) (AFOSR-TN-58-361) (AF 61-514)1080) AD 154266; PB 142539 Unclassified

An analysis is presented of the deviations in equivalence rules to show that they can be explained by influences obtained from the linearized equation of motion of a perfect fluid. The flow potential of a body with source-sink distribution in a plane of symmetry is discussed. Assumptions pertaining to the source-sink distribution allow a decomposition of the potential with certain postulated properties to be given. The result will be a modified theorem of equivalence, the Keune-Oswatitsch formulation being a special case that holds only if the source-sink distribution is subject to a stronger condition of equivalence. A modified area-rule is formulated showing that bodies not equivalent in the restricted sense generally do not satisfy the modified area-rule. Comparison of theoretical results is made with the results of a numerical computation carried out on a computer.

THM.03:005

Technische Hochschule. [Physikalisches Inst.] Munich (Germany).

AN EXAMPLE FOR THE PRACTICAL CALCULATION OF SUPERSONIC FLOW FIELDS PAST OSCILLATING BODIES OF REVOLUTION BY A METHOD DUE TO SAUER, by J. Muench. Aug. 4, 1958, 16p. incl. diagrs. tables. (Technical note no. 5) (AFOSR-TN-58-881) (AF 61(514)1080) AD 203907; PB 136740 Unclassified

An example is given of the calculation with electronic computers of supersonic flow fields past bodies of revolution oscillating slowly and with small amplitudes. (Contractor's abstract)

THM.03:006

Technische Hochschule. [Physikalisches Inst.] Munich (Germany).

AUXILIARY TABLES FOR THE COMPUTATION OF LINEARIZED WING-BODY INTERFERENCE FLOWS, by H. J. Stetter. Nov. 10, 1958, 1v. incl. diagrs. tables. (Technical note no. 6) (AFOSR-TN-58-1089) (AF 61(514)1080) AD 207586 Unclassified

An analysis of the Fourier-decomposition used in the third step of the quasi-cylindrical method for the treatment of the linear wing-body interference problem shows that in a certain region, the convergence of the resulting Fourier series is necessarily poor. Tables are presented of the universal portion of the solution of the third step giving the values of the flow component accounting for the local pressure coefficient in a large number of points on both wing and body. Instruction is

TEM.02:001 - TEM.02:004

provided on the use of these tables which reduce the necessary computations to those of the well convergent second portion of the solution. (ASTIA abstract)

TEM.02:001

Temple U. Dept. of Physics, Philadelphia, Pa.

SPECTRAL REFLECTIVITY AS A FUNCTION OF TEMPERATURE OF β -BRASS TYPE ALLOYS, by L. Muldawer. Oct. 15, 1957, 20p. diagrs. tables, refs. (AFOSR-TN-57-667) (AF 49(638)73) AD 136656 Unclassified

A number of β -brass type alloys undergo reversible color changes as a function of temperature. β -Brass turns copper-red at about 250°C, the color change taking place gradually. β -AgZn is pink at room temperature, it is silver gray at 250°C. Similar changes have been observed in β -AgCd, β -AuZn, and β -AuCd. Color changes consistent with the above observations have been noted on cooling to liquid nitrogen temperatures. Although disordering takes place in some of these alloys it is not thought that these color change phenomena are primarily due to disordering or to surface films. Quantitative measurements of reflectivity as a function of wavelength at several temperatures have been made on β -CuZn, β -AgZn, β -AuZn, β -AgCd, and α -brass. The reflectivity edge for β -brass shifts from 5000Å at 27°C to 5300Å at 275°C. This is a shift of about 5.6×10^{-4} ev/°C. No such edge shift was observed with α -brass or with copper, gold, or Cu_3Au as judged visually. It is believed that these color shifts are due to changes in the energy spacings of electron bands. (Contractor's abstract)

TEM.02:002

Temple U. [Dept. of Physics] Philadelphia, Pa.

REVERSIBLE TEMPERATURE EFFECTS IN THE REFLECTIVITY OF CsCl TYPE ALLOYS (Abstract), by L. Muldawer. [1957] [1]p. [AF 49(638)73] Unclassified

Presented at annual meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 58, Jan. 30, 1957.

A number of CsCl structure alloys undergo reversible color changes as a function of temperature. β -Brass turns copper-red at about 250°C, the color changes taking place gradually. β -AgZn is pink at room temperature, it is silver-gray at 250°C. Similar changes have been observed in β -AgCd, β -AuZn, and β -AuCd. Color changes consistent with the above observations have been noted on cooling to liquid nitrogen temperatures.

Although disordering takes place in some of these alloys it is not thought that this color change phenomenon is primarily due to disorder or to surface films. Quantitative measurements of reflectivity as a function of wavelength at several temperatures have been made on β -brass, β -AuZn, and gold modified β -AgZn and β -AgCd. The reflectivity minimum for β -brass at 27°C is at 4750Å, while at 275°C it is at 5000Å. This is a shift of about 5×10^{-4} ev/°C. No such color effects were observed with Cu, Au, Cu_3Au , or α -brass. The possible nature of the effect is to be discussed.

TEM.02:003

Temple U. [Dept. of Physics] Philadelphia, Pa.

EFFECT OF COLD WORK ON THE SPECTRAL REFLECTIVITY OF CsCl TYPE ALLOYS (Abstract), by L. Muldawer. [1957] [1]p. [AF 49(638)73] Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 144, Mar. 21, 1957.

Many CsCl structure alloys are normally strongly colored but tend toward silver-gray upon cold working. The normal color is regained as a function of time even when the specimen is not in contact with air. This color recovery is presumably associated with the mechanical recovery of such alloys which occurs at room temperature. Spectral reflectivity curves show that cold working is similar to increased temperature in some respects. In β -brass, the reflectivity minimum disappears, the steepness of the reflectivity edge lessens, and the difference in reflectivity on either side of the edge decreases. Similar effects are seen with β -AgZn, β -AgCd, and β -AuZn. Inasmuch as the strain produced by cold work is extremely inhomogeneous, it should be expected that the reflectivity edge would be smeared out. The possible nature of this effect is considered.

TEM.02:004

Temple U. Dept. of Physics, Philadelphia, Pa.

EFFECTS OF TEMPERATURE AND COLD WORK ON OPTICAL PROPERTIES OF METALS AND ALLOYS, by L. Muldawer. Final rept. Oct. 15, 1958 [26]p. incl. diagrs. refs. (AFOSR-TR-58-140) (AF 49(638)73) AD 204553 Unclassified

Alloys similar in character to β -brass have been studied with respect to spectral reflectivity and color as a function of temperature and surface treatment. Large changes in reflectivity edge position and color were

TEM.01:007 - TEM.01:010

observed for changes in temperature; a tendency toward edge disappearance was observed upon cold working. Alloys which are basically face-centered cubic do not show those properties. Electron and x-ray diffraction studies indicate stress induced phase transformations in many of the alloys of the β -brass type. The discussion presents a correlation of the observed results with known simple theory. (Contractor's abstract)

TEM.01:007

Temple U. Research Inst., Philadelphia, Pa.

HEXACARBON DINITRIDE, C_6N_2 , OR DICYANODIACETYLENE, by A. J. Saggiomo. Dec. 19, 1956, 19p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-57-33) (AF 18(600)1475) AD 115068
Unclassified

Also published in Jour. Org. Chem., v. 22: 1171-1175, Oct. 1957.

The synthesis of dicyanodiacetylene, or hexacarbon dinitride C_6N_2 is described. The pure compound is stable, at room temperature, in the absence of O_2 .

Vapor pressure, infrared spectral data and other physical properties are reported.

TEM.01:008

Temple U. Research Inst., Philadelphia, Pa.

THE PURE OZONE TO OXYGEN FLAME, by A. G. Streng and A. V. Grosse. Jan. 30, 1957, 4p. incl. diagr. table. (AFOSR-TN-57-55) (AF 18(600)1475) AD 115094
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 1517-1518, Mar. 20, 1957.

Studies of the behavior of pure ozone with various fuel gases and of the decomposition of O_3 to O_2 are presented. A stable ozone-oxygen flame was found to exist and a maximum flame temperature of 2677°K was recorded with 100 mol-% O_3 in O_2 . Burning velocities for the O_3 - O_2 reaction were determined by the standard schlieren method and compared with the theoretical data of von Kármán. Pure ozone when mixed with cyanogen produces a flame temperature of 5200°K.

TEM.01:009

Temple U. Research Inst., Philadelphia, Pa.

PREMIXED OZONE-HYDROGEN FLAME, by A. G.

Streng and A. V. Grosse. [Apr. 1957] 5p. illus. tables. (AFOSR-TN-57-193) (AF 18(600)1475) AD 126488
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 3296-3297, June 20, 1957.

In this study, it is pointed out that pure O_3 can be mixed with pure H_2 at -78° and even at 20° and 1 atm without explosion, and with no, or practically no, reaction for several hr. Pure O_3 - H_2 mixtures of any desired composition were prepared by mixing known volumes of the 2 gases. The mixtures were burned at -78° initial temperature. The experimental burning velocities at 195°K initial temperature and 1 atm were for 6.0, 12.0, 18.2, 18.5, 25.0, and 100 mol-% O_3 , respectively, 207 ± 5 , 644 ± 57 , 1290 ± 20 , 1330 ± 30 , 1680 ± 80 , and 270 ± 7 cm/sec. Mixtures of 94.0 to 75% H_2 (the rest being pure O_3) were readily burned. The resulting O_3 - H_2 flames are brighter than the corresponding O_2 flames, but their luminosity is also low. The stoichiometric mixture burns very rapidly at 1680 ± 80 cm/sec. In mixtures on the O_3 -rich side of the stoichiometric point, the flame front degenerates rapidly to a detonation front. Such mixtures cannot be burned successfully.

TEM.01:010

Temple U. Research Inst., Philadelphia, Pa.

THE PREMIXED OZONE-CYANOGEN FLAME, by A. G. Streng and A. V. Grosse. [1957] 4p. incl. diagr. (AFOSR-TN-57-305) (AF 18(600)1475) AD 132376
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 5583, Oct. 20, 1957.

Static experiments showed that $(CN)_2$ and pure O_3 can be mixed and stored for a considerable time without reaction. The mixture $3(CN)_2 + 4O_3$ was kept in a 100 cc pyrex vessel, at 1000 mm Hg at 0°C for two hr with no noticeable change in pressure; identical results were obtained with the mixture, $3(CN)_2 + 2O_3$. Burning velocities of $(CN)_2$ - O_3 mixtures containing 25.0, 33.3, 40.0 and 100.0 mol-% O_3 were, respectively, 60 ± 3 , 242 ± 12 , 285 ± 6 , and 420 ± 6 cm/sec. A mixture beyond the stoichiometric point, on the O_3 -rich side, containing 50.0 at-% O_3 detonated immediately upon ignition. All flames on the $(CN)_2$ -rich side up to and including the mixture burning to $2CO + N_2$ burn uniformly, noiselessly, as brightly as an electric arc and with a pink-violet color. The $2(CN)_2 + O_3$ flame is particularly bright and has a

TEM.01:011 - TEM.01:015

different characteristic blue-green color. The temperatures of the flames ($^{\circ}\text{K} \pm 2^{\circ}$) for $(\text{CN})_2 + \text{O}_2$ and $3(\text{CN})_2 + 2\text{O}_3$ at 1.0 and 10.0 atm are 4856 and 5025, and 5208 and 5506 $^{\circ}$, respectively.

TEM.01:011

Temple U. Research Inst., Philadelphia, Pa.

PURE OZONE FLAMES, ALONE AND WITH VARIOUS FUEL GASES, by A. V. Grosse and A. G. Streng. Aug. 1, 1957, 1v. incl. illus. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-57-511) (AF 18(600)1475) AD 136497 Unclassified

This report covers the experiments conducted at Temple, first, to combust pure ozone to oxygen, and, second, pure ozone with various fuel gases, such as hydrogen, cyanogen, methane, carbon monoxide, and ethylene. Static experiments have shown that all of the above gases, with the exception of carbon monoxide and ethylene, can be premixed with pure ozone. After this had been established premixed flames with pure ozone were burned successfully and the burning velocities determined and compared with the corresponding oxygen flames. As was to be expected, the ozone flames are substantially faster than the corresponding oxygen flames. This is particularly true in the cases of flames containing the element hydrogen. An Appendix covering a critical review of the physical properties of ozone, as well as of ozone-oxygen mixtures, has been prepared. (Contractor's abstract)

TEM.01:012

Temple U. Research Inst., Philadelphia, Pa.

HIGH TEMPERATURE RESEARCH, by C. S. Stokes. [1957] [2]p. incl. illus. (AF 18(600)1475) Unclassified

Published in Armed Forces Chem. Jour., v. 11: 24-25, May-June 1957.

Research which is currently going on at the Research Institute at Temple University in the field of high temperature is outlined here. The purpose is defined as being twofold: (1) to obtain, maintain, and contain high temperatures; and (2) to study the chemical and physical phenomena taking place at these temperatures.

TEM.01:013

Temple U. Research Inst., Philadelphia, Pa.

DETONATION VELOCITY OF GASEOUS OZONE, by A.

G. Streng, C. S. Stokes, and L. A. Streng. Dec. 5, 1957, 14p. incl. illus. diagrs. tables, refs. (Technical note no. 5) (AFOSR-TN-58-14) (AF 18(600)1475) AD 148052 Unclassified

Also published in Jour. Chem. Phys., v. 29: 458-459, Aug. 1958.

The detonation velocities of pure 100% gaseous ozone and ozone-oxygen mixtures have been measured and compared with theoretical calculations. The average for 100% gaseous ozone is 1863 ± 20 m/sec at 1.0 atm, and 25 $^{\circ}\text{C}$, and is in good agreement with the theoretical value. The experimental detonation velocities for 75% and 50 vol-% ozone (at the same initial conditions) are 1782 ± 40 and 1633 ± 20 m/sec, respectively. The calculated detonation properties of liquid ozone are presented. (Contractor's abstract)

TEM.01:014

Temple U. Research Inst., Philadelphia, Pa.

IMAGING OF THE OXYGEN-ALUMINUM FLAME AND ITS USE AS AN ARTIFICIAL SUN FURNACE, by W. E. Marceau. June 16, 1958, 18p. incl. illus. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-58-606) (AF 18(600)1475) AD 162131 Unclassified

An artificial sun furnace has been constructed by the use of two parabolic reflectors and an aluminum-oxygen torch which produces an image temperature of 2700 $^{\circ}\text{K}$ and has a heat flux at the image of 57 cal/sq cm/sec. The image diameter has been found to be approximately 0.75 in. The image is formed inside of a quartz bulb which can be used as a controlled atmosphere furnace. Design improvements are suggested for the construction of a furnace with higher image temperatures and larger sized images.

TEM.01:015

Temple U. Research Inst., Philadelphia, Pa.

PREMIXED FLAMES OF CYANOGEN AND THE ENDOTHERMIC OXIDES OF NITROGEN AND THE PREMIXED, PREHEATED OXY-CYANOGEN FLAME, by C. S. Stokes, R. P. M. Werner and others. Sept. 2, 1958, 24p. incl. diagrs. tables, refs. (Technical note no. 7) (AFOSR-TN-58-810) (AF 18(600)1475) AD 202355; PB 137838 Unclassified

Also published in Indus. Engineering Chem., v. 52: 75-78, Jan. 1960. (Title varies)

The combustion of cyanogen with some oxides of nitrogen, namely N_2O , NO and NO_2 , has been studied and the stoichiometry of the nitric oxide-cyanogen flame experimentally verified. Theoretical flame temperatures of

TEM.01:016, 017; TEN.01:003;
TAM.01:010, 011

the reactions between cyanogen and N_2O , NO , NO_2 , and N_2O_4 were calculated. Burning velocity was measured as a function of temperature for the oxy-cyanogen flame and as a function of concentration for the combustion of cyanogen with oxygen and also with the oxides of nitrogen. The oxy-cyanogen flame had the highest burning velocity which occurred at maximum oxygen atom concentration. The candlepower of the oxy-cyanogen flame has been measured over a range of varying cyanogen concentration.

TEM.01:016

Temple U. Research Inst., Philadelphia, Pa.

COMBUSTION OF METALS IN OXYGEN, by A. V. Grosse and J. B. Conway. [1958] [10]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Office of Naval Research, Office of Ordnance Research, and Air Force Office of Scientific Research under [AF 18-(600)1475]) Unclassified

Published in Indus. Engineering Chem., v. 50: 663-672, Apr. 1958.

The basic aim of the work was to develop a technique for producing and utilizing high temperature sources. Combustion of aluminum yields a source of high intensity thermal radiation. Powdered metal-oxygen flames are highly effective in cutting through thick sections of concrete and ceramic materials. (Contractor's abstract)

TEM.01:017

Temple U. Research Inst., Philadelphia, Pa.

THE COMBUSTION OF ZIRCONIUM IN OXYGEN, by W. L. Doyle, J. B. Conway, and A. V. Grosse. [1957] [8]p. incl. illus. diagrs. tables, refs. (AF 18(600)1475) Unclassified

Published in Jour. Inorg. and Nuclear Chem., v. 6: 138-144, Apr. 1958.

The combustion of zirconium in oxygen leads to one of the highest temperatures obtainable by the combustion of metals. This temperature has been estimated from available thermodynamic data to be 4930°K at 1.0 atm pressure. A technique has been developed which enables a powdered zirconium-oxygen flame to be operated, thus producing the highest metal flame temperature reported to date. (Contractor's abstract)

TEN.01:003

Tennessee U., Knoxville.

INITIAL VALUE PROBLEMS AND TIME-PERIODIC SOLUTIONS FOR A NONLINEAR WAVE EQUATION, by F. A. Ficken and B. A. Fleishman. [Dec. 1956] [26]p. incl. refs. (AFOSR-TN-58-722) (Sponsored jointly by Office of Naval Research, Office of Bureau of Ordnance, and Air Force Office of Scientific Research under AF 18-(600)313) AD 145262(a) Unclassified

Also published in Communications on Pure and Appl. Math., v. 10: 331-356, Aug. 1957.

This is item no. TEN.01:002 of Volume I which was subsequently assigned the TN no. AFOSR-TN-58-722.

TAM.01:010

Texas A. and M. Coll. Dept. of Physics, College Station.

THE VIBRATIONAL ANALYSIS OF THE 2700-4800A ABSORPTION SYSTEM OF ClO_2 AND THE VIBRATIONAL CONSTANTS OF THE ASSOCIATED ELECTRONIC STATES, by J. B. Coon and E. Ortiz. Mar. 25, 1957 [14]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-57-136) (AF 18(600)439) AD 120493 Unclassified

Also published in Jour. Molecular Spectroscopy, v. 1: 81-94, Sept. 1957.

A critical list of 143 vibronic bands of the 2700-4800A absorption system of ClO_2 vapor is compiled. Vibrational quantum number assignments are given to 117 of these bands. Five progressions (a), (b), (c), (m), (d) including the four strongest are given the assignments (a) (v_1 '00) - (000), (b) (v_1 '10) - (000), (c) (v_1 '02) - (000), (m) (v_1 '12) - (000), (d) (v_1 '04) - (000). The fact that three of the anharmonicity constants are calculated in several independent ways with consistent results is regarded as support for this analysis. The three zero order frequencies and the six anharmonicity constants are determined for the excited electronic state. Furthermore, by combining information obtained from electronic spectra with that obtained from known infrared data, the nine vibrational constants of the ground electronic state are determined. An explanation of anomalous intensities is suggested.

TAM.01:011

Texas A. and M. Coll. [Dept. of Physics] College Station.

THE 3960A ABSORPTION SYSTEM OF H_2CO VAPOR, by S. E. Hodges, J. R. Henderson and J. B. Coon. Nov. 1957 [5]p. incl. tables, refs. (AFOSR-TN-57-704) (AF 18(600)439) AD 200737 Unclassified

TAM.01:012, 013; TAM.02:004

Presented at Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 10-14, 1957.

Also published in Jour. Molecular Spectroscopy, v. 2: 99-102, Apr. 1958.

Four temperature sensitive bands belonging to the 3960A absorption system ($^3A_2 - ^1A_1$) of H_2CO vapor are reported. The bands of this system may be interpreted in terms of an inversion in the out-of-plane bending coordinate of the excited state. The temperature sensitive bands permit a determination of the inversion splittings ($0^- - 0^+$) = $36 \pm 2 \text{ cm}^{-1}$ and ($1^- - 1^+$) = $244 \pm 2 \text{ cm}^{-1}$ with splitting centers differing by 640 cm^{-1} .

TAM.01:012

Texas A. and M. Coll. [Dept. of Physics] College Station.

INEQUALITY OF BOND DISTANCES IN ClO_2 (Abstract), by J. B. Coon, J. K. Ward, and C. M. Lloyd. [1957] [1]p. [AF 18(600)439] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Mar. 1-2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 100, Mar. 1, 1957.

Four v_1' progressions (a), (b), (c), and (d) dominate the appearance of the 3000-5000A absorption system of ClO_2 vapor. If it is assumed that $r_1'' = r_2''$ and $r_1' = r_2'$, where r designates a Cl-O bond distance, the four progressions must be given the excited state assignments (a), (v_1' '00); (b), (v_1' '10); (c), (v_1' '02); and (d), (v_1' '04). All four progressions are assigned to the (000) level of the ground state. However, a calculation of Condon overlap integrals leads to an intensity ratio $I(c)/I(a) = 0.02$ which compares poorly with the observed ratio 0.5. Similarly, the calculated value of $I(d)/I(a) = 0.0006$ compares poorly with the observed value of about 0.15 for this ratio. The large value of the observed intensities of progressions (c) and (d) may be explained by assuming a slight difference in bond distances for the excited state. This alters the selection rules, and the assignments (c), (v_1' '01) and (d), (v_1' '02) may be made. On the basis of this interpretation, large intensity ratios are possible. Calculations are being made to test whether each of the foregoing observed intensity ratios is explained by the same inequality of bond distances for the excited state.

TAM.01:013

Texas A. and M. Coll. Dept. of Physics, College Station.

ROTATIONAL ANALYSIS OF THE 3400 - 3900A ABSORPTION SYSTEM OF SULPHUR DIOXIDE, by R. K. Russell. Jan. 1958, 16p. incl. diagrs. tables, refs. (AFOSR-TN-58-122) (AF 18(600)439) AD 152030

Unclassified

Presented at meeting of the Texas Academy of Science, Southern Methodist U., Dallas, Dec. 12-14, 1957.

Partially resolved rotational structure of two bands of the 3400 - 3900A absorption system of SO_2 have been investigated. The results $\Delta(A-B) = 0.282$ and $\Delta B = -0.0364$. These results confirm the values of these rotational constants obtained by a quantitative application of the Franck-Condon principle. The bands are shown to have perpendicular polarization. (Contractor's abstract)

TAM.02:004

Texas A. and M. Coll. [Dept. of Physics] College Station.

NUCLEAR MAGNETIC RESONANCE RELAXATION IN BINARY SOLUTIONS (Abstract), by R. W. Mitchell and M. Eisner. [1958] [1]p. [AF 18(600)1300] Unclassified

Presented at meeting of the Amer. Phys. Soc., Ithaca, N. Y., June 19-21, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 262, June 19, 1958.

Spin-lattice relaxation times for hydrogen nuclei were measured as a function of concentration for the following binary solutions: $C_6H_6 - CCl_4$, $C_6H_6 - CS_2$, $C_6H_{12} - CCl_4$ and $C_6H_{12} - CS_2$. Both the rotational and translational correlation times are found to be proportional to the macroscopic solution viscosity. The rotational and translational contributions to T_1 have been calculated for C_6H_6 and C_6H_{12} from this data. The rotational correlation times are found to be 4.3×10^{12} for C_6H_6 and 4.6×10^{12} for C_6H_{12} , both values referring to the pure solutions. T_1 measurements were also made for both resonance lines in $C_6H_6 - C_6H_{12}$ solutions. The contribution of the $C_6H_6 - C_6H_{12}$ collisions to the relaxation of both lines has been calculated by subtracting off the rotational and like translational contributions obtained from the previously measured correlation times.

TAM.02:005; TEX.02:009-011

TAM.02:005

Texas A. and M. Coll. [Dept. of Physics] College Station.

CONCENTRATION DEPENDENCE OF CHEMICAL SHIFTS AND T_1 's FOR PROTONS IN AQUEOUS SOLUTIONS OF ACETIC ANHYDRIDE (Abstract), by M. Eisner. [1957] [1]p. [AF 18(600)1300] Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 384, Dec. 19, 1957.

T_1 and chemical shifts have been measured, at 5000 gauss, for protons in both OH and CH_3 groups in aqueous solutions of acetic anhydride. No shift is observed between the OH and CH_3 until acetic acid proportions are reached; the subsequent shifts are in substantial agreement with those reported by Bhar and Linstrom. Both T_1 's exhibit minima, however, they display different dependence on the macroscopic viscosity. An analysis of the T_1 variations, in the region of the anomalous behavior of the chemical shifts, seems to lend support to the explanation of this anomaly in terms of the effect of an active solvent on the dimer-monomer equilibrium.

TEX.02:009

Texas U. Defense Research Lab., Austin.

DEVELOPMENT OF SUBSONIC AND SUPERSONIC TOTAL TEMPERATURE PROBES FOR A BLOW-DOWN TYPE WIND TUNNEL, by G. L. Alexander. June 1957, 45p. Incl. illus. diagrs. tables, refs. (Rept. no. DRL-399) (AFOSR-TN-57-164) (AF 18(600)589) AD 126456 Unclassified

This study is an experimental approach to the development of supersonic and subsonic total temperature probes for a blow-down type wind tunnel. Probes of small mass and relatively low conductive heat loss were developed for subsonic testing. Heated shields were used to determine the magnitude of radiation errors, and a supersonic, heated shield probe was developed. In both the subsonic and supersonic cases the probes performed with less than 1/2 percent error. This accuracy could be maintained over wide ranges of temperature variations and transient conditions.

TEX.02:010

Texas U. Defense Research Lab., Austin.

A HIGH STAGNATION TEMPERATURE INTERMITTENT

FLOW SUPERSONIC WIND TUNNEL, by J. L. Harkness. Mar. 11, 1957, 48p. incl. illus. diagrs. refs. (Rept. no. DRL-406) (AFOSR-TN-57-222) (AF 18(600)589) AD 126520 Unclassified

A high stagnation temperature intermittent-flow supersonic wind tunnel is described. Preliminary design considerations are briefly outlined, while the bulk of the report concerns the detailed description of the resulting test facility. Each basic component of the wind tunnel circuit is described along with the currently available instrumentation for model testing. The design and development work for the major components of the circuit have been described in other reports, with the exception of the working section of the tunnel, and these reports are referenced herein to avoid duplication. One section is included covering the design and fabrication of the supersonic nozzles in detail. This was considered consistent with a following section that presents the flow calibration data using the Mach number 5.0 nozzle. Mach number distributions in the supersonic test region as well as stagnation temperature distributions in the stilling chamber and supersonic test region are included.

TEX.02:011

Texas U. Defense Research Lab., Austin.

THEORETICAL AND EXPERIMENTAL STUDIES OF BOUNDARY LAYER CHARACTERISTICS AT SUPERSONIC SPEEDS IN AIR, INCLUDING INVESTIGATIONS OF SKIN FRICTION, VELOCITY DISTRIBUTION AND HEAT TRANSFER, by J. L. Harkness. Annual rept. Jan. 5, 1957, 27p. illus. diagrs. tables. (AF 18(600)589) Unclassified

The major portion of this report concerns the experimental phase of the program. A first section under this phase presents the final development work on the wind-tunnel circuit including special equipment additions and general instrumentation revisions and additions. A second section presents a summary of the complete calibration testing in the wind tunnel. The special instrumentation developed for this purpose is described, and the final results of the testing are presented. A special heated-shield, thermocouple-probe was developed for the measurement of stagnation temperatures in the stilling chamber and test section region, and a complete description of this investigation is included. The calibration work represents the largest portion of the effort during the subject report period. A third section reports the present status of the flat-plate heat transfer models and includes a brief description of this unit. The theoretical effort has concerned only the analytical investigations necessary under the experimental phase, and a brief discussion of this work is presented. A final section reports the coordination efforts on the project. (Contractor's abstract)

TEX.02:012 - TEX.02:016

TEX.02:012

Texas U. Defense Research Lab., Austin.

USE OF VARIABLE FEEDBACK TO COMPENSATE FOR NON-LINEARITIES AND DESIGN UNCERTAINTIES IN A CLOSED-LOOP SYSTEM, by W. H. Hartwig. [1957] 18p. illus. tables, refs. (AF 18(600)589)

Unclassified

Presented at Ninth annual Southwestern Inst. of Radio Engineers Conf., Houston, Tex., Apr. 11-13, 1957.

Design of a heat exchanger of 420 kw capacity to maintain stagnation temperature constant in a supersonic blow-down wind tunnel was the basic problem. The transfer functions for the individual elements of the system contained significant amounts of non-linearities of several types. In addition, determination of the essential constants of the system was inadequate due to inability to predict the system interactions. This paper describes the theoretical design of the system. Equipped with feedback adjustments the system was built and stabilized on the first trial. The theoretical transfer function is shown to predict the performance actually measured. (Contractor's abstract)

TEX.02:013

Texas U. Defense Research Lab., Austin.

TEMPERATURE DISTRIBUTION STUDIES IN THE TURBULENT BOUNDARY LAYER FOR COMPRESSIBLE FLOW WITHOUT HEAT TRANSFER, by E. H. Alford. Jan. 1958, 1v. incl. diagrs. tables. (Rept. no. DRL-421) (AFOSR-TN-58-4) (AF 18(600)589) AD 148043

Unclassified

Van Driest's boundary layer temperature equation is modified in an attempt to account for the Prandtl number not being unity. The modified theory is applied to existing data at Mach numbers of 2.00, 2.50, and 5.00. A study is made of the effect of temperature recovery coefficient, Mach number and Reynolds number upon an introduced parameter that represents the modified theory. It is determined that the theory accounts for a variable Prandtl number for turbulent flow and can be used to predict the temperature distribution in a compressible turbulent boundary layer for the case of zero heat transfer with reasonable accuracy. (Contractor's abstract)

TEX.02:014

Texas U. Defense Research Lab., Austin.

INTERFERENCE EFFECTS BETWEEN TOTAL-PRESSURE PROBES IN THE BOUNDARY LAYER OF

A SUPERSONIC WIND TUNNEL, by J. R. Lacy. Jan. 1958, 1v. incl. illus. diagrs. (Rept. no. DRL-420) (AFOSR-TN-58-6) (AF 18(600)589) AD 148045

Unclassified

An experimental investigation was undertaken in a 6 x 6 in. Mach number 5 wind tunnel to determine the extent of any mutual interference effects between total-pressure probes in supersonic flow. Blunt-nosed total-pressure probes of 0.035 in. outside diam were tested at several different positions in the wall boundary layer of the wind tunnel. The results of these tests indicated the definite presence of mutual interference between total-pressure probes at a spacing between probes of approximately 0.025 to 0.030 in. An approximate method of determining shock wave shape and location ahead of plane and axially symmetric bodies was utilized to provide an indication of minimum probe spacing to prevent mutual interference between probes of other sizes. (Contractor's abstract)

TEX.02:015

Texas U. Defense Research Lab., Austin.

HEAT TRANSFER MEASUREMENTS ON A FLAT PLATE MODEL AT MACH NUMBER 5.0, by J. L. Harkness. Jan. 8, 1958, 1v. incl. illus. diagrs. tables, refs. (Rept. no. DRL-423) (AFOSR-TN-58-74) (AF 18(600)589) AD 148118

Unclassified

The results of heat transfer measurements made on a flat plate model in a 6x7-in. wind tunnel at a free-stream Mach number of 5.05 are presented. The internal surface of the model was cooled, and the heat transfer rate was determined by measuring the temperature drop across the model once temperature stabilization was achieved. A general description of the wind tunnel facility used is presented and a description of the design and construction details of the heat transfer model is given. The results of the tests are discussed and the data are presented both in tabular form and graphically for comparison with existing theories. Some laminar data were obtained but in most cases the flow over the model was largely turbulent. It is concluded that the turbulent theory of Van Driest (item no. NAA-01-003) predicts values at least 15% below the measured values. (Contractor's abstract)

TEX.02:016

Texas U. Defense Research Lab., Austin.

HEAT TRANSFER INVESTIGATIONS IN SUPERSONIC FLOW, by J. L. Harkness. Final rept. Jan. 5, 1953-Feb. 5, 1958. Mar. 4, 1958, 1v. incl. illus. diagrs. tables, refs. (Rept. no. DRL-429) (AFOSR-TN-58-21) (AF 18(600)589) AD 152023

Unclassified

The major effort concerned the development of a small

TEX.04:038-041; TEX.06:001

high stagnation temperature intermittent-flow supersonic wind tunnel and a description of this work and the resulting facility is presented. The development of an electrically heated shield temperature probe, for measurements in supersonic flow, is described and the results of an interference study, concerning total pressure probes in the boundary layer, are presented. Heat transfer measurements on a flat-plate model were accomplished and this investigation is described including a brief discussion of the test results. An analytical study concerning the temperature distribution through the turbulent boundary layer is also discussed. (Contractor's abstract)

TEX.04:038

Texas U. Dept. of Chemistry, Austin.

EFFECTS OF HIGH PRESSURE ON THE NEAR ULTRAVIOLET ABSORPTION SPECTRA OF BENZENE AND MONOSUBSTITUTED BENZENES, by W. W. Robertson, S. E. Babb, Jr., and F. A. Matsen. [1957] [4]p. incl. diagrs. tables, refs. (AF 18(600)430)

Unclassified

Published in Jour. Chem. Phys., v. 26: 367-370, Feb. 1957.

The near ultraviolet absorption spectra of benzene and several monosubstituted benzenes have been obtained in the vapor phase with partial pressures of nitrogen up to 550 atm and in hydrocarbon solution with pressures up to 5500 atm. The spectra broaden asymmetrically and shift to longer wavelengths under pressure. The wavelength varies linearly with dielectric constant, both in the vapor phase and in solution, $\Delta\lambda/\Delta K$ lying between 20 and 29 Å. A rough correlation is found between $\Delta\lambda/\Delta K$ and the oscillator strength of the transition. (Contractor's abstract)

TEX.04:039

Texas U. Dept. of Chemistry, Austin.

CHEMICAL KINETICS IN LINEAR FLOW SYSTEMS, by J. R. Streetman and F. A. Matsen. [1958] 5p. (AFOSR-TN-58-39) (AF 18(600)430) AD 148080

Unclassified

Kinetic equations for a single reactant in a linear flow system were developed. These equations permit the determination of the macroscopic kinetic parameters, the reaction order, and the specific reaction rate. In the system under consideration the total pressure is assumed constant and the concentration of the reactant and the flow rate are varied. The treatment is an extension of that given by Hulburt.

TEX.04:040

Texas U. [Dept. of Chemistry] Austin.

THE FORMATION OF BENZENE IN THE PYROLYSIS OF ACETYLENE, by W. W. Robertson, E. M. Magee, and F. A. Matsen. Jan. 1958, 6p. incl. refs. (AFOSR-TN-58-73) (AF 18(600)430) AD 148119

Unclassified

Also published in Jour. Appl. Chem., v. 8: 401-402, July 1958.

The facts related to the formation of benzene in the pyrolysis of acetylene are reexamined. The preponderance of evidence from many sources makes the presence of benzene in the products of decomposition a near certainty. It is pointed out how the benzene spectrum may be overlooked in the ultraviolet region unless care is taken to remove strongly absorbing materials that mask its presence. (Contractor's abstract)

TEX.04:041

Texas U. Dept. of Chemistry, Austin.

HALOPROPARGYL ALCOHOLS AND ETHERS, by L. F. Hatch, W. E. Blankenstein, and S. H. Chu. [1958] [5]p. incl. table. (AF 18(600)430; continued by AF 49-(638)35)

Unclassified

Published in Jour. Org. Chem., v. 23: 397-401, Mar. 1958.

The following compounds have been prepared and characterized: 2,3-dibromo-2-propen-1-ol, 3-bromo-3-chloro-2-propen-1-ol, 1,1-dibromo-3-ethoxy-1-propene, 1,1-dibromo-3-phenoxy-1-propene, 1-bromo-1-chloro-3-ethoxy-1-propene, 1-bromo-1-chloro-1-propene, 1,3-dibromo-1-chloro-1-propene, 3-bromo-2-propyn-1-ol, 3-chloro-2-propyn-1-ol, 1-bromo-3-ethoxy-1-propyne, 1-bromo-3-phenoxy-1-propyne, 1-chloro-3-ethoxy-1-propyne. The stereochemistry of the addition of bromine to cis- and trans-1-chloro-1-propene followed by dehydrohalogenation is discussed. (Contractor's abstract)

TEX.06:001

Texas U. [Dept. of Chemistry] Austin.

THERMAL DECOMPOSITION OF BUTANE, by J. [A.] Cunningham, R. McGuire and others. Dec. 1957 [24]p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-58-49) (AF 18(603)142) AD 148089

Unclassified

An initial series of measurements of the rate of decomposition of butane made in a special flow reactor gave an order of reaction and rate constants in essential

TEX.06:002-005; TEX.05:015

agreement with results of others, but the energy of activation found was quite low. Further experiments, using direct calibrations of the analytical apparatus and improved flow control made by two different investigators confirmed the previous results. The decomposition is essentially first order and the rate constant for the initial stages of reaction is $k = 3.5 \cdot 10^9 \exp - 46,000/RT \text{ sec}^{-1}$. The value of the energy of activation found is about 12,000 cal/mol less than that established by others. However, their data also indicate a trend toward a lower value for the initial decomposition reaction itself, without the complications of later steps; and the approach to calculations used here represents an improved method for extrapolating to zero conversion. (Contractor's abstract)

TEX.06:002

Texas U. [Dept. of Chemistry] Austin.

EXPLORATORY EXPERIMENTS ON SURFACE DEPOSITS ON METALS FROM PYROLYSIS OF HYDROCARBONS, by J. H. Dent and R. C. Anderson. Dec. 1957, 5p. (Technical note no. 2) (AFOSR-TN-58-50) (AF 18(603)142) AD 148090 Unclassified

Exploratory experiments have been made on surface reactions of acetylene and hexane with various metals over ranges of 250-900°. These results show that specific interactions occur between the gases and certain metals, under conditions where physical condensation is highly unlikely. Tests with octatriyne indicate that such compounds may be chemisorbed, and that they can activate a surface for further reaction and deposit formation. Quantitative study of such systems is now being undertaken. (Contractor's abstract)

TEX.06:003

Texas U. [Dept. of Chemistry] Austin.

THERMAL DECOMPOSITION OF BUTANE II, by J. [A.] Cunningham and R. C. Anderson. Aug. 1958 [28]p. incl. diagrs. tables. (Technical note no. 3) (AFOSR-TN-58-761) (AF 18(603)142) AD 201860 Unclassified

Experimental studies of the thermal decomposition of butane have been extended to additional temperatures and to a wider range of flow velocities. The effects of increased surface, and of added oxygen and ethylene oxide were also investigated. The overall rate equation, extrapolated to the earliest stages of reaction was found to be $k = 8.0 \times 10^7 e^{-39,300/RT}$. This differs markedly from results of earlier work in the low apparent energy of activation. Possibilities of surface effects or trace catalytic or inhibitory effects, which might cause such a variation, have been carefully checked, but no evidence of such an effect has yet been found. (Contractor's abstract)

TEX.06:004

Texas U. [Dept. of Chemistry] Austin.

CHEMICAL KINETICS IN LINEAR FLOW SYSTEMS I, by J. A. Cunningham and F. A. Matsen. Oct. 1958 [8]p. incl. diagrs. table. (Technical note no. 4) (AFOSR-TN-58-872) (AF 18(603)142) AD 203916 Unclassified

Equations are developed describing the kinetics in a flow system assuming parabolic flow. While these equations are more complex than the equations for planar flow, they do not improve the description of the thermal decomposition of butane. (Contractor's abstract)

TEX.06:005

Texas U. Dept. of Chemistry, Austin.

DECOMPOSITION OF BUTANE IN A LINEAR FLOW REACTOR (Abstract), by J. A. Cunningham, F. A. Matsen, and R. C. Anderson. [1958] [1]p. [AF 18(603)-142] Unclassified

Presented at meeting of the Phys. Chem. Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Published in 134th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 51-S.

The pyrolysis of butane has been studied in a linear flow reactor, using vapor-liquid partition chromatography for analysis of the products. The resulting data have been used to find the order of reaction, specific reaction velocity constants, and the apparent activation energy by a mathematical treatment for flow systems developed by Matsen, Streetman, and Cunningham. Temperatures in the range of 560° to 600° were used at atmospheric pressure. Residence times were of the order of 10 to 80 sec. The products of reaction are primarily propene and methane or ethene and ethane, and the reaction is essentially homogeneous and first order. These results, and the specific reaction constant in the region of 580°, are in good agreement with the results of other workers. Analysis of the temperature effect, however, gives energy of activation factors of 40 to 46 kcal/mol (depending upon the extent of reaction involved). These values are markedly lower than those of earlier investigators.

TEX.05:015

Texas U. [Dept. of Physics] Austin.

ANGULAR CORRELATION OF ANNIHILATION RADIATION IN ALKALI HALIDE CRYSTALS, by W. E. Millett and R. Castillo-Bahena. [1957] 24p. incl. diagrs. tables, refs. (AFOSR-TN-57-393) (AF 33(038)20681) AD 132468 Unclassified

TEX.05:016 - TEX.05:018

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 37-38, Jan. 30, 1957.

Also published in Phys. Rev., v. 108: 257-262, Oct. 25, 1957.

A new type of instrument has been used for measurements on Mg metal and single crystals of LiF, NaCl, KCl, KBr, and KI. The data, after correction for instrument resolution, yield the momentum distribution of either the photons or the center of mass of the positron and electron just prior to annihilation. The momentum distribution obtained for NaCl is accounted for by assuming (a) that the positron is bound to the chloride ion in an s state, (b) that annihilation takes place with one of the electrons of the closed shell, and (c) that the overlap wave function is of the form $(r-b)^2 e^{-mr}$. Best agreement with experiment was obtained for 30% of the annihilations taking place with s electrons for which $b = 0.75 \text{ \AA}$, and $m = 3.64 \text{ \AA}^{-1}$ and the other 70% with p electrons for which $b = 0.70 \text{ \AA}$ and $m = 4.00 \text{ \AA}^{-1}$.

TEX.05:016

Texas U. [Dept. of Physics] Austin.

NEW TYPE OF APPARATUS FOR MEASUREMENT OF THE ANGULAR CORRELATION OF ANNIHILATION RADIATION (Abstract), by R. Castillo-Bahena and W. E. Millett. [1957] [1]p. [AF 33(038)20681]

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Series II, v. 2: 37, Jan. 30, 1957.

The apparatus described in previous investigations of this type makes use of two rectangular collimators. The angular acceptance in one plane is made narrow but that in the other plane is broad. The new type of apparatus makes use of a circular slit in one collimator and a circular hole in the other. The advantages obtained by this arrangement may be understood by considering the following fact. If one of two annihilation gamma rays correlated at an angle θ passes along a line, then its partner must pass along a cone of angle θ which is symmetric about the line of the first. The new arrangement therefore has an increased solid angle without deterioration of the resolution. In fact, both the solid angle and the resolution are increased by going from rectangular slits to circular slits. The method of determining the resolution curves of the apparatus and of correcting the data according to these resolution curves is discussed.

TEX.05:017

Texas U. [Dept. of Physics] Austin.

MEASUREMENT OF TOTAL AND DIFFERENTIAL CROSS SECTIONS BY FAST COINCIDENCE DETECTION OF D-D NEUTRONS AND THEIR HELIUM-3 RECOILS (Abstract), by E. W. Bennett, P. L. Okhuysen and others. [1957] [1]p. [AF 33(038)20681] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 232, Apr. 25, 1957.

One-hundred kev deuterons strike an occluded deuteron target. The neutrons and a collimated beam of helium-3 recoils are detected in coincidence. The helium-3 recoils are detected with anthracene and the neutrons with terphenyltoluene scintillators. The ratio of coincidences in the defined beam to that out of the beam is about one thousand. The total cross sections of several elements and the differential cross section of lead for 2.7-mev neutrons have been measured.

TEX.05:018

Texas U. [Dept. of Physics] Austin.

MEAN LIFE OF POSITRONS IN ALKALI HALIDE CRYSTALS (Abstract), by L. Brown, C. [R.] Hatcher, and W. E. Millett. [1957] [1]p. [AF 33(038)20681] Unclassified

Presented at meeting of the Amer. Phys. Soc., Boulder, Colo., Sept. 5-7, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 314, Sept. 5, 1957.

The mean life of positrons in LiF, NaCl, KCl, and KI has been measured by using Gerholm's technique. Only a fast component has been observed and the capabilities of the equipment are such as to reveal any long component accounting for more than 1% of the annihilations. The values obtained in units of 10^{-10} sec are LiF 2.3, NaCl 3.2, KCl 3.2, and KI 3.1; the probable error associated with each measurement is 0.3. Measurements were made of the mean lives in Al and Teflon for comparison with the work of other investigators. Good agreement with the values reported by Gerholm was found except that no long component was observed in Al; the effect on which the report of the long component had been based was observed but the same effect was noticed in the four crystals and, to a lesser extent, in the Co^{60} resolution curve.

TEX.05:019 - TEX.05:023

TEX.05:019

Texas U. [Dept. of Physics] Austin.

ANNIHILATION OF POSITRONS IN ORGANIC COMPOUNDS, by C. R. Hatcher, W. E. Millett, and L. Brown. [1958] 14p. incl. diagrs. tables, refs. (AFOSR-TN-58-138) (AF 33(038)20681) AD 152185

Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 377, Dec. 19, 1957.

Also published in Phys. Rev., v. 111: 12-15, July 1, 1958.

Positrons emitted from Na^{22} have been used to study the lifetimes and the ratio of decays in long and short modes. The mode with a lifetime 10 fold larger has been found to occur from 35% to 4% of the times and have been lifetime from 1.6 to 2.5×10^{-9} sec for a series of organic compounds, most of which are derived from benzene. A correlation between the lifetime of the long mode and the molecular structure has been found. The observed lifetimes in benzene and its halogen derivatives decrease as the size of the halogen increases. As the bond strength of the weakest bond increases and as the asymmetry of the molecule increases, the lifetime is found to decrease.

TEX.05:020

Texas U. [Dept. of Physics] Austin.

CALCULATION OF THE $\text{O}^{16}(\alpha, p)\text{O}^{17}$ ANGULAR DISTRIBUTION, by J. L. Richter and E. V. Ivash. [1958] [5]p. incl. diagrs. refs. (AFOSR-TN-58-192) (AF 33(038)20681) AD 152225

Unclassified

Also published in Phys. Rev., v. 111: 245-249, July 1, 1958.

Results of calculations based on the Tobocman theory are presented for the angular distribution of the outgoing protons produced by the $\text{O}^{16}(\alpha, p)\text{O}^{17}$ stripping reaction in which the residual nucleus is left either in the ground state or in the first excited state, and for incident energies well below the Coulomb barrier. A variety of nuclear models are examined, including the optical model, and the theoretical distributions compared with experimental ones. (Contractor's abstract)

TEX.05:021

Texas U. [Dept. of Physics] Austin.

DETECTION OF FAST NEUTRONS BY THE ASSOCI-

ATED PARTICLE METHOD, by P. L. Okhuysen, E. W. Bennett and others. [1958] [16]p. incl. diagrs. refs. (AFOSR-TN-58-669) (Sponsored jointly by Air Force Office of Scientific Research under AF 33(038)20681 and Wright Air Development Center Aeronautical Research Lab.) AD 162201

Unclassified

Also published in Rev. Scient. Instruments, v. 29: 982-985, Nov. 1958.

The techniques used to measure the total cross sections of the $\text{D}(d, n)\text{He}^3$ reaction by means of the associated particle method of detection of the neutrons are described. A measurement of the time of flight of $\text{T}(d, n)\text{He}^4$ neutrons that have been used in inelastic scattering has also been accomplished by the associated particle method. A description is given of the experimental procedure used.

TEX.05:022

Texas U. [Dept. of Physics] Austin.

QUENCHING OF POSITRONIUM LIFETIMES BY MOLECULAR IODINE, by C. R. Hatcher and W. E. Millett. [1958] 11p. incl. diagrs. table. (AFOSR-TN-58-683) (AF 33(038)20681) AD 226867

Unclassified

Presented at meeting of the Amer. Phys. Soc., Austin, Tex., Mar. 6-7, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 100, Mar. 6, 1959.

Also published in Phys. Rev., v. 112: 1924-1926, Dec. 15, 1958.

The mean life of the τ_2 component of the decay of iodine in normal heptane solutions has been measured and used to find a cross section of 10^{-17} cm^2 for the collision annihilation of triplet positronium by molecular iodine. A decrease is observed in the τ_2 mean life as the iodine concentration in solution increases and this quenching has been attributed to an enhancement of pickoff annihilation resulting either from formation of positronium iodide or from high polarizability of the iodine molecule. The intensity of the τ_2 component seems to decrease as the iodine concentration increases, but large errors in the data render this point inconclusive.

TEX.05:023

Texas U. [Dept. of Physics] Austin.

INELASTIC SCATTERING OF NEUTRONS FROM IRON

TEX.05:024; TEX.07:001-003

AND LEAD BY TIME OF FLIGHT (Abstract), by P. Okhuysen and W. E. Millett. [1958] [1]p. [AF 33(038)-20681] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 165, May 1, 1958.

The energy distributions of the neutrons emitted at 90° from a beam of 14.9 mev neutrons incident upon iron and lead scatterers have been obtained using a simplified associated-particle time-of-flight technique. This technique was originated by O'Neill and has been modified in the present experiment. The apparatus will be described and the energy distributions from iron and lead will be presented.

TEX.05:024

Texas U. [Dept. of Physics] Austin.

ANNIHILATION OF POSITRONS IN S, C, Cu, AND BI (Abstract), by F. Castillo-Jimenez, J. B. Ashe, and W. E. Millett. [1958] [1]p. [AF 33(038)20681] Unclassified

Presented at meeting of the Amer. Phys. Soc., British Columbia U., Vancouver (Canada), Aug. 26-28, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 326-327, Aug. 26, 1958.

The angular correlation of two-photon annihilation radiation has been studied by means of an apparatus having conical geometry. The data have been analyzed to give $N(p)$, the number of pairs which annihilate with momentum p , as a function of p . There is a noticeable difference between the momentum distributions for monoclinic and rhombic sulfur and for diamond and graphite. The curves for Cu and Bi are in agreement with previous results which indicate that for decay in metals annihilation occurs primarily with Fermi electrons. A new apparatus, using the same type of geometry but having better resolution, has been used to study oriented graphite in two positions. A slightly different $N(p)$ curve was obtained when the sample was rotated 90° about an axis perpendicular to the axis of the apparatus.

TEX.07:001

Texas U. Dept. of Physics, Austin.

PRESSURE EFFECTS ON THE ULTRAVIOLET ABSORPTION SPECTRA OF SOME AROMATIC COMPOUNDS, by W. W. Robertson, O. E. Weigang, Jr.,

and F. A. Matsen. Apr. 1957 [31]p. Incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-57-61) (AF 49(638)35; continuation of AF 18(600)430) AD 120401 Unclassified

Also published in Jour. Molecular Spectroscopy, v. 1: 1-10, July 1957.

A study is presented of the change in frequency of an electronic absorption band of a chromophore on change in the surrounding medium. Changes in the medium have been affected not by choosing different solvents, but by varying the density of one solvent, n-pentane, through the application of pressures up to 5,500 bars. Aromatic hydrocarbons were chosen as chromophores for which several transitions could be observed, thereby maintaining constant several important factors. The observations are discussed in terms of the London formula for dispersion forces. (Contractor's abstract)

TEX.07:002

Texas U. [Dept. of Physics] Austin.

INTERMOLECULAR FORCES AND PRESSURE SHIFTS OF THE SPECTRA OF AROMATIC HYDROCARBONS, by W. W. Robertson, S. E. Babb, Jr., and O. E. Weigang, Jr. [1957] 1v. Incl. illus. diagrs. refs. (AFOSR-TN-57-601) (AF 49(638)35) AJ 36586 Unclassified

Also published in Internat'l. Colloquium on the Optical and Acoustical Properties of Compressed Fluids and Molecular Interactions. Bellvue (France) (July 1-6, 1957), Paris, Centre National de la Recherche Scientifique, 1959, p. 293-310.

The absorption spectra of liquid benzene and of benzene, several monosubstituted benzenes, and a number of condensed ring aromatics in solution in n-pentane have been recorded at hydrostatic pressures up to 6000 bars. The vapor spectrum of benzene in various diluent gases has been taken over a wide density range and in carbon dioxide at temperatures above and below the critical temperature. A red shift in the absorption spectrum of the chromophore results from an increase in density of solvent or diluent gas in every case with the exception of helium, which produces a blue shift. The rate of shift of frequency with density is found to be a linear function of the oscillator strength of the transition for the stronger transitions and essentially constant for the very weak transitions. Various theoretical interpretations are considered. (Contractor's abstract)

TEX.07:003

Texas U. Dept. of Physics, Austin.

PHASE CHANGES AND SPECTRAL SHIFTS, by W. W.

TEX.07:004 - TEX.07:007

Robertson and S. E. Babb, Jr. [1957] 5p. diags.
(AFOSR-TN-57-660) (AF 49(638)35) AD 136653
Unclassified

Also published in Jour. Chem. Phys., v. 28: 953-955,
May 1958.

The absorption spectrum of benzene has been obtained in the diluents carbon dioxide, ethylene and ethane over a wide range of densities both above and below the critical temperatures. The red spectral shifts are linear functions of the density throughout the density range for ethylene and ethane and are independent of the state of the diluent. A break in the linear wave-length-density curve occurs at high densities of carbon dioxide. These results support the view that gases and liquids are essentially the same thing in those cases where specific interactions are not involved and suggest further that the radial distribution remains constant from low to high densities of gas and into the liquid state. (Contractor's abstract)

Presented at Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 10-14, 1957.

Published in Symposium on Molecular Structure and Spectroscopy. Abstracts, 1957, p. 48.

The near ultraviolet vapor absorption spectrum of benzene has been recorded in various diluent gases covering a density range that extends from the vapor density of benzene through the density region of liquid hydrocarbons. The wavelength of absorption shifts to the red smoothly with an increasing slope with increasing density of diluent gas, but is linear with dielectric constant. The frequency of absorption then decreases with increasing dielectric constant and has an increasing slope. The smoothness of the curves suggests that there is no essential difference in mechanism between that described by the collision theory generally used to interpret wavelength shifts resulting from intermolecular interactions at low densities and the mechanism described by the statistical theory that would be applied in the region of liquid densities. Data is presented on carbon dioxide as a diluent, both above and below the critical temperature. Behavior in liquid and gaseous phases at equal densities is presented.

TEX.07:004

Texas U. Dept. of Physics, Austin.

ENHANCEMENT OF INFRARED ABSORPTION BANDS
OF CHARGE TRANSFER COMPLEXES, by E. E.
Ferguson and F. A. Matsen. [1958] 9p. incl. refs.
(AFOSR-TN-57-771) (AF 49(638)35) AD 148001
Unclassified

Also published in Jour. Chem. Phys., v. 29: 105-107,
July 1958.

An enhancement of infrared absorption bands is shown to be inherent in charge-transfer theory due to change in vertical ionization energy or change in vertical electron affinity during the course of molecular vibration. A semiquantitative calculation of the intensity enhancement of the symmetric ring stretching vibrational mode of benzene in the benzene-iodine complex agrees well with the experimentally observed value. This result shows that previous investigators' assumptions of charge-transfer complex asymmetry, based on observed infrared absorption bands may not be valid. (Contractor's abstract)

TEX.07:006

Texas U. Dept. of Physics, Austin.

EFFECTS OF HYDROSTATIC PRESSURE ON THE
INTENSITY OF THE SINGLET-TRIPLET TRANSITION
OF α -CHLORONAPHTHALENE IN ETHYL IODIDE, by
W. W. Robertson and R. E. Reynolds. [1958] 11p.
diags. (AFOSR-TN-58-297) (AF 49(638)35)
AD 154206; PB 133955
Unclassified

Also published in Jour. Chem. Phys., v. 29: 138-141,
July 1958.

The extinction coefficient of the singlet-triplet transition of α -chloronaphthalene in ethyl iodide was found to increase almost linearly with the density of the compressed mixture. Study of a 1:2 vol ratio of these components over a pressure range from 1 to 3644 atm resulted in about a two-fold increase in light absorption, with little other changes in band envelope. No increase in absorption coefficient was obtained for pure liquid α -chloronaphthalene subjected to comparable increase in hydrostatic pressure. The increase in extinction coefficient was attributed to the increase in collisional frequency resulting from the increase in concentration of the constituents and the corresponding decrease in the liquid "cage" dimensions with increased density.

TEX.07:005

Texas U. [Dept. of Physics] Austin.

EFFECTS OF HIGH PRESSURE ON THE NEAR UL-
TRAVIOLET VAPOR ABSORPTION SPECTRUM OF
BENZENE IN VARIOUS DILUENT GASES (Abstract),
by W. W. Robertson and S. E. Babb, Jr. [1957] [1]p.
(AF 49(638)35) Unclassified

TEX.07:007

Texas U. Dept. of Physics, Austin.

SPECTROSCOPIC COMPARISON OF $\pi - \sigma$ TO $\pi - \pi$

TEX.07:008; TEX.08:001;
THL.01:001, 002; THL.02:001

ELECTRON FORCES BETWEEN BENZENE AND VARIOUS DILUENT MOLECULES, by W. W. Robertson, J. M. Robinson, and S. E. Babb, Jr. [1958] [5]p. incl. diagr. (AFOSR-TN-58-347) (AF 49(638)35) AD 154252
Unclassified

Also published in Jour. Chem. Phys., v. 23: 243-244, July 1958.

The wave length shift with pressure of the near UV absorption spectrum of benzene in ethane with benzene in ethylene, and of benzene in pentane with liquid benzene have been compared. Within the range of experimental error, the wave length shift of benzene with density of ethylene and of ethane was found to be linear from low through high diluent densities and from the gas into a liquid phase. The benzene-ethylene and benzene-ethane $\pi - \pi$ and $\pi - \sigma$ electron interactions have been calculated by using the methods developed by Haugh and Hirschfelder. The $\pi - \pi$ energies are found to be roughly twice as large as the $\pi - \sigma$ energies, so that little difference is to be expected in the ground state interaction energy between benzene in an unsaturated solvent and benzene in a saturated solvent since each double bond is replaced by two single bonds. Excited state interaction energies have not been calculated, but it is assumed that these energies are larger than, but proportional to, the ground state interaction energies.

TEX.07:008

Texas U. Dept. of Physics, Austin.

CHARGE TRANSFER ENHANCEMENT OF INFRARED ABSORPTION BANDS OF BENZENE, by E. E. Ferguson and F. A. Matsen. [1958] 11p. incl. refs. (AF 49(638)35) AD 162246
Unclassified

The intensity of the 992 cm^{-1} infrared band of the benzene-iodine charge transfer complex is calculated semiquantitatively with a model in which the dipole moment changes as a result of a variation in the vertical ionization energy of benzene during symmetric ring stretching. The calculation agrees well with the observed intensity, demonstrating a consistency between the Mulliken charge transfer theory and the "Axial" C_{6v} Bz-I₂ complex symmetry previously deduced from infrared selection rules. (Contractor's abstract)

TEX.08:001

Texas U. Dept. of Zoology, Austin.

THE GENETIC EFFECTS OF COSMIC RAYS, by W. S. Stone. Final rept. July 29, 1958, 4p. incl. table. (AFOSR-TR-58-104) (AF 49(638)51) AD 162246; PB 136887
Unclassified

Cosmic radiation is interesting as one of the features

of the universe, as a physical tool, and as a source of biological danger and damage. As humans investigate and move into space, the biological damage, including possible damage to humans, will increase. It is necessary to measure the amount of damage encountered in space to be prepared to protect organisms. This hazard includes genetic damage and these experiments are intended to measure this factor. Microorganisms were prepared and sent to Minnesota for balloon flights as called for between December 1, 1956 through May 31, 1958. Control tests were run in the laboratory to test spontaneous mutation rates with these materials. The one successful short flight, 780, in which our material was flown carried Neurospora spores, which were tested for the presence of mutations by direct mutation test.

THL.01:001

[Thiokol Chemical Corp.] Reaction Motors, Inc., Denville, N. J.

[JET MIXING STUDY] by J. J. Lovingham, E. B. Greenberg, and S. Reider. Final rept. June 7, 1954-Jan. 15, 1957, 1v. incl. illus. diagrs. tables, refs. appendices. (Rept. no. RMI-038-F) (AFOSR-TR-57-28) (AF 18(600)1184) AD 126457
Confidential

THL.01:002

[Thiokol Chemical Corp.] Reaction Motors, Inc., Denville, N. J.

JET MIXING AS A COMBUSTION TOOL, by J. J. Lovingham. [1957] [24]p. incl. illus. diagrs. tables. [ARS publication no. 514-57] (AF 18(600)1184)
Unclassified

Presented at Twelfth annual meeting of the Amer. Rocket Soc., New York, Dec. 2-5, 1957.

The interdependencies of the preparatory processes affecting the precombustion treatment of propellants in a liquid rocket engine are not fully understood. As an aid in obtaining an insight into this problem area an analytical and experimental investigation was undertaken. This study had as its goal the establishment of the relationships between the parameters controlling these processes. The analytical approach taken was a dimensional analysis which served to establish parameters. These parameters were later experimentally evaluated in a specially built 5000-lb thrust rocket engine. (Contractor's abstract)

THL.02:001

[Thiokol Chemical Corp.] Reaction Motors, Inc., Denville, N. J.

RELATIONSHIP OF IGNITION DELAY TO COMBUSTION

THI.03:001; TIL.01:001;
TOR.01:006-008

CHARACTERISTICS OF PROPELLANTS (Unclassified title), by S. Tannenbaum and P. Barbaccia. Final technical rept. May 15, 1956-Apr. 30, 1957. June 27, 1957, 50p. incl. illus. diagrs. tables. (Rept. no. RMI-082-F) (AFOSR-TR-57-52) (AF 18(603)102) AD 136445
Confidential

THI.03:001

Thiokol Chemical Corp. Reaction Motors Div.,
Denville, N. J.

STUDY OF IONIZATION IN ROCKET FLAMES (Abstract), by R. Ellison. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 126674) (AF 49(638)305)
Unclassified

Presented at Conf. on Ion and Plasma Research,
Maryland U., College Park, Sept. 30-Oct. 2, 1958.

The development of an ionization probe for use with rocket flames has been attacked as part of a project to measure and to manipulate the ionization in rocket engines. Data taken in open flames indicates that: (1) refractory coatings on water cooled probes interfere with the desired measurement; (2) water cooling of a given probe design results in a lower probe current than measured with the same probe and no cooling; and (3) uncooled probe measurements are comparable to measurements reported in the literature. The design assembly and testing of a laboratory micromotor has been completed using hydrogen and oxygen gases. Initial measurements of ionization in the chamber are reported to the extent data are obtained.

TIL.01:001

Tiltman Langley, Ltd., Surrey (Gt. Brit.).

RESEARCH ON STUDY OF THE TURBULENT FLAME PROPERTIES OF ELEMENTARY COMUSTION CHAMBER FLOW PATTERNS, by A. B. Miller, A. Capella, and D. B. Spalding. Feb. 24, 1958, 1v. incl. illus. diagrs. tables. (Technical scientific note no. 1) (AFOSR-TN-58-388) (AF 61(514)1213) AD 154296
Unclassified

The main purpose was to examine the validity of tracer techniques used in prediction of flame phenomena for combustion-chamber design. The flow behind an axially symmetrical baffle 1.37 in. diam, 3.88 in. long with 45° included angle nose cone in a 2.87 in. duct was examined at one Reynolds number. The technique used was to inject argon steadily at one point, and determine its concentration at another, many pairs of points being considered. The development of the technique and rig is given in detail. (Contractor's abstract)

TOR.01:006

Toronto U. Inst. of Aerophysics (Canada).

THEORY OF FREE-MOLECULE, ORIFICE-TYPE PRESSURE PROBES IN ISENTROPIC AND NONISENTROPIC FLOWS, by G. N. Patterson. Apr. 1959 [15]p. incl. illus. (UTIA rept. no. 40, rev) (AFOSR-TN-57-13) (AF 18(600)1185) AD 217779
Unclassified

The theory of a pressure probe is presented in the form of an orifice in the side of a tube which may be orientated in any direction relevant to that of the mass motion and which is so small compared with the local mean free path, that free-molecule flow occurs. The theory shows that such a tube will measure the local speed ratio in isentropic and nonisentropic flows and suggests that in strong shock waves it may be possible to determine the viscosity and heat conduction, that is, the deviation from Maxwellian molecular motion. (Contractor's abstract)

TOR.01:007

Toronto U. Inst. of Aerophysics (Canada).

PERFORMANCE OF A MACH 4 AXIALLY SYMMETRIC NOZZLE DESIGNED TO OPERATE AT 40 MICRONS HG IN THE UTIA LOW DENSITY WIND TUNNEL, by A. V. Sreekanth. Sept. 1956 [68]p. incl. illus. diagrs. tables. (UTIA Technical note no. 10) (AFOSR-TN-57-94) (AF 18(600)1185) AD 120443
Unclassified

The performance of a Mach 4 axisymmetric nozzle designed to operate at a test chamber pressure of 40μ of Hg was investigated in the UTIA low density wind tunnel both at the design condition and for other values. The anticipated Mach number distribution was obtained at the design operating conditions. The results of a series of runs at pressures from 29 to 46μ of Hg indicated that the boundary layer displacement thickness varied inversely as the square root of the operating static pressure. The boundary layer thickness at the nozzle throat, as determined from mass flow measurements, agreed well with the calculated value based on the assumption of zero rate of boundary layer growth at the throat. Additional investigations were made on the effect of the stagnation temperature and the pressure in the open jet test chamber on the flow.

TOR.01:008

Toronto U. Inst. of Aerophysics (Canada).

PRESSURE PROBES AT VERY LOW DENSITY, by K. R. Enkenhus. Jan. 1957, 1v. incl. illus. diagrs. tables, refs. (UTIA rept. no. 43) (AFOSR-TN-57-237) (AF 18(600)1185) AD 126534
Unclassified

Experimental tests of conventional impact probes and

TOR.01:009 - TOR.01:011

of a new type of probe (orifice probe) were made in the transition-flow regime and in free-molecule flow. The data may be applied to relate pressure readings to the free-stream Mach number when calibrating rarefied gas streams. The readings of conventional impact probes having 10° internally and externally chamfered mouths and a length/radius ratio of 50 are compared with the Rayleigh supersonic pitot-tube formula over the range $1.2 \leq M_1 \leq 2.0$, $0.36 \leq R_e \leq 41$, and with

continuum and free-molecule flow theory in subsonic flows over the range $0.13 \leq M_1 \leq 0.95$, $0.011 \leq R_e \leq$

0.11. At a Reynolds number of 1, the measured impact pressure at $M = 2$ was twice that given by the Rayleigh formula, and even larger departures from continuum theory were obtained in subsonic flows. The orifice probe, which consisted of a cylinder transverse to the stream with an orifice for taking pressure readings pierced in a piece of tinfoil cemented over an opening in the side, gave results which agreed with free-molecule flow theory in tests made in a subsonic nozzle at $M = 0.13$ to 0.86 and Knudsen numbers from 6.6 to 8.6 . From extensive tests in the transition flow region at Mach numbers up to 2 , an empirical formula was devised expressing orifice probe pressure readings as a function of Mach and Knudsen number from continuum to free-molecule flow. The pressure distribution around a cylinder in free-molecule flow was determined by rotating an orifice probe on its axis at several subsonic Mach numbers; the results agreed well with theory.

TOR.01:009

Toronto U. Inst. of Aerophysics (Canada).

MOLECULAR APPROACH TO PROBLEMS OF HIGH-ALTITUDE, HIGH-SPEED FLIGHT, by G. N. Patterson. May 1957 [65]p. incl. illus. diagrs. tables, refs. (UTIA Review no. 10; NATO AGARD rept. no. 134) (AFOSR-TN-57-311) (AF 18(600)1185) AD 132382

Unclassified

Presented at Eleventh meeting of the Wind Tunnel and Model Testing Panel, Scheveningen (Netherlands), July 8-12, 1957.

In order to obtain a better understanding of the aerodynamics of high performance aircraft it is necessary to investigate the effects of rarefaction and high temperatures on the flow of gases. Both effects show the increasingly important role played by the molecular structure of a gas in its macroscopic motion. In the introductory sections of this review it is pointed out that flight at very high speed can only occur at extreme altitudes. The zones of the upper atmosphere, the regimes of fluid mechanics based on considerations of rarefaction and temperature, and the modern experimental methods for investigations in some of these regimes are discussed. Rarefaction effects are then discussed in terms of gas

surface interactions, free molecule flow and slip flow, and Newtonian flow is considered as an extension of free molecule motion. The effects of high temperature are indicated for undissociated air and air in dissociation equilibrium, and the important effects of relaxation are outlined. (Contractor's abstract)

TOR.01:010

Toronto U. Inst. of Aerophysics (Canada).

THE DESIGN, INSTRUMENTATION AND OPERATION OF THE UTIA LOW DENSITY WIND TUNNEL, by K. R. Enkenhus. June 1957, 1v. incl. illus. diagrs. tables, refs. (UTIA rept. no. 44) (AFOSR-TN-58-22) (AF 18-(600)1185) AD 148061

Unclassified

The UTIA low density wind tunnel is a continuous, open circuit tunnel with vacuum pump drive designed to operate at Mach numbers up to 5 over a range of low pressures suitable for the study of rarefied gas flows. Booster-type oil diffusion pumps are used to provide a range of operating pressures from 0.001 to 0.070 mm

Hg for Reynolds numbers of 0.1 to 4×10^3 per inch. The design, construction, operation, and instrumentation of the tunnel are presented. A theoretical study of conventional nozzles and slotted wall nozzles with boundary-layer suction and the calibration of axisymmetric nozzles for Mach 4 , Mach 2 and subsonic flow are given. These nozzles have solid walls and were operated at pressures of 0.040 , 0.020 , and 0.008 mm Hg, respectively. The flow in the supersonic nozzles is essentially a continuum flow at low Reynolds number with the boundary layer filling most of the jet, while in the subsonic nozzle the density was low enough to produce slip on the walls. New studies of outgassing effects on pressure probes in free molecule flow are given in an appendix. A bibliography of low density references is included in the report. (Contractor's abstract, modified)

TOR.01:011

Toronto U. Inst. of Aerophysics (Canada).

PROPERTIES OF IMPACT PRESSURE PROBES IN FREE MOLECULE FLOW, by E. L. Harris and G. N. Patterson. Apr. 1958 [18]p. incl. diagrs. tables. (UTIA rept. no. 52) (AFOSR-TN-58-582) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)1185 and Canadian Defence Research Board) AD 162102

Unclassified

An expression has been derived for the mass flow through a circular tube in free molecule flow when the tube and gas are in relative motion. The gas entering the tube is assumed to have a Maxwellian distribution function and the molecular reflection process at the wall is assumed to be diffuse. The theory has been used to

TOR.01:012, 013; TOR.02:001, 002

determine the pressure read by an impact probe in free molecule flow. Although the general expressions derived apply to any value of gas velocity and tube size, the detailed calculations for the pressure probe are difficult except for the case of low speeds and long tubes. An experimental check of the theory has been carried out using impact probes in a whirling arm apparatus and in the UTIA low density wind tunnel. Agreement between theory and experiment is quite satisfactory. (Contractor's abstract)

TOR.01:012

Toronto U. Inst. of Aerophysics (Canada).

PRESSURE MEASUREMENTS IN FREE MOLECULE FLOW WITH A ROTATING ARM APPARATUS, by E. P. Muntz. May 1958, 1v. incl. illus. diagrs. tables, refs. (UTIA Technical note no. 22) (AFOSR-TN-58-904) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1185 and Canadian Defence Research Board) AD 204431

Unclassified

A rotating arm apparatus was developed and used to measure the impact pressures of orifice and long tube type pressure probes in the free molecule flow regime. Using this equipment, the validity for low speed ratios, of a theory for the pressure rise in long tube free molecule impact probes was established. An approximate short tube theory is also presented, and its application to the geometrical conditions necessary to provide an effective true orifice is discussed. (Contractor's abstract)

TOR.01:013

Toronto U. Inst. of Aerophysics (Canada).

INVESTIGATION OF FREE-MOLECULE AND TRANSITION FLOWS NEAR THE LEADING EDGE OF A FLAT PLATE, by E. L. Harris. Nov. 1958 [88]p. incl. illus. diagrs. table, refs. (UTIA rept. no. 53) (AFOSR-TN-58-1043) (AF 18(600)1185) AD 206757; PB 144754

Unclassified

Pressure measurements using orifice probes were made in the flow over a thin flat plate set parallel to the stream in the UTIA low-density wind tunnel. The length of the plate was approximately 7 mean free paths and speed ratios of 0.55 and 0.78 were used. Reasonably good agreement between theoretical and experimental pressures in a region less than one mean free path downstream from the leading edge demonstrated the existence of free molecule flow in this region. Velocity gradients made the results concerning the nature of the flow over the complete plate qualitative. In an appendix theoretical and experimental results are given on the pressure indicated by an impact probe in free molecule flow when the length of the probe is not small with respect to its diameter. (Contractor's abstract)

TOR.02:001

Toronto U. Inst. of Aerophysics (Canada).

AN EXPERIMENTAL INVESTIGATION OF THE OSCILLATING PRESSURES ON A CIRCULAR CYLINDER IN A FLUID STREAM, by D. M. McGregor. June 1957 [35]p. incl. illus. diagrs. table. (UTIA Technical note no. 14) (AFOSR-TN-58-339) [(Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)249] and Canadian Defence Research Board) AD 154243

Unclassified

Results of experimental investigations of the fluctuating pressures on a circular cylinder are presented. The cylinder was mounted in a wind tunnel at right angles to the flow and contained within it the microphone used as the pressure transducer. By making assumptions about the correlation of the pressure around the circumference of the cylinder, estimations were made - by integration of the surface pressure coefficients - of the oscillating lift and drag coefficients of the cylinder. The lift coefficient remained essentially constant at approximately 0.6, while the drag coefficient decreased with increasing speed from approximately 0.075 to 0.044. It was found that the pressure level of the fundamental frequency was very low at the front of the cylinder, but rose sharply to a large maximum at the sides. After remaining constant over an appreciable arc ($\approx 60^\circ$), it decreased to the background level at the rear. The level of the second harmonic was masked by the background except in the rear 1/3 of the cylinder where it increased steadily to a maximum in the downstream direction. An attempt was made to develop a simple mathematical model of the flow by considering an alternating vortex standing at the rear of the cylinder. This endeavor met with moderate success. (Contractor's abstract)

TOR.02:002

Toronto U. Inst. of Aerophysics (Canada).

UTIA AIR DUCT FACILITY FOR INVESTIGATION OF VIBRATION NOISE INDUCED BY TURBULENT FLOW PAST A PANEL (BOUNDARY-LAYER NOISE), by L. Maestrello. Apr. 1958 [20]p. incl. illus. diagrs. tables, refs. (UTIA Technical note no. 20) (AFOSR-TN-58-358) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)249 and Canadian Defence Research Board) AD 154263; PB 134706

Unclassified

An acoustically quieted air-duct facility has been constructed for the purpose of investigating the boundary layer noise generated by turbulent flow past a flexible panel. The facility is basically an open-circuit wind-tunnel with interchangeable 33 ft rectangular duct sections 12 in. wide and 1 in., 2 in., 4 in., or 8 in., deep. The downstream end of the duct, where fully developed channel flow is obtained, contains the test panel, fitted flush in one wall. Maximum speed in the 4 in. duct using

TOR.02:003 - TOR.02:006

a 10 hp blower is 200 fps. Details of the design and the aerodynamic performance such as the velocity profiles and pressure gradients are given.

TOR.02:003

Toronto U. Inst. of Aerophysics (Canada).

ON THE STRENGTH DISTRIBUTION OF NOISE SOURCES ALONG A JET, by H. S. Ribner. Apr. 1958 [26]p. incl. diagrs. refs. (UTIA rept. no. 51) (AFOSR-TN-58-359) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)249 and Canadian Defence Research Board) AD 154264; PB 132745
Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 30: 876, Sept. 1958.

The spatial distribution of noise sources along a jet is investigated by application of Lighthill's theory to regions of so-called similar profiles. The analysis refers to the noise power emitted by a section of the jet between two adjacent planes normal to the axis, as a function of distance x of the section from the nozzle. It is found that this power is essentially constant with x in the initial mixing region and falls off as x^{-7} in the region about 10 diameters downstream from the nozzle in the fully developed jet. Because of this striking attenuation of strength with distance, it is concluded that the mixing region produces the bulk of the noise and must dominate in muffler behavior; conversely, the 'fat' part of the jet must contribute much less to the total noise power than is commonly supposed. A qualitative interpretation is given of Powell's experiments on the effects of nozzle velocity profile on total noise power, as is the behavior of multiple-nozzle or corrugated mufflers, both as to the overall quieting and frequency-shifting. The possibility emerges that such mufflers may be improved without serious thrust loss by the addition of a sound-attenuating shroud. (Contractor's abstract, modified)

TOR.02:004

Toronto U. Inst. of Aerophysics (Canada).

NOTE ON ACOUSTIC ENERGY FLOW IN A MOVING MEDIUM, by H. S. Ribner. Apr. 1958 [8]p. incl. diagrs. (UTIA Technical note no. 21) (AFOSR-TN-58-360) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)249 and Canadian Defence Research Board) AD 154265; PB 134663
Unclassified

Both acoustic energy density and energy flow are known to be modified by motion of the medium, as in a jet. Comparison is made of similarities and discrepancies in the formulas of three investigators in order to infer a correct formulation. Example applications show how variations in the velocity of a stream carrying plane

sound waves can change the 'linear theory' acoustic energy density from positive through zero to negative, with corresponding changes in the energy flow. (Contractor's abstract)

TOR.02:005

Toronto U. Inst. of Aerophysics (Canada).

CANADIAN RESEARCH IN AERODYNAMIC NOISE, by B. Etkin and H. S. Ribner. July 1958 [59]p. incl. illus. diagrs. refs. (UTIA Review no. 13) (AFOSR-TN-58-860) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)249 and Canadian Defence Research Board) AD 203662
Unclassified

Presented at meeting of the First Internat'l. Congress in the Aeronaut. Sciences, Madrid (Spain), Sept. 8-13, 1958.

Also published in Advances in Aeronaut. Sciences, v. 1: 393-426, 1959. (Title varies)

Canadian research on flow noise and some aspects of the aircraft noise problem is described. Specific experimental and/or theoretical investigations include: Aeolian Tones; Boundary Layer Noise (rigid wall and flexible wall); Effects of Boundary Layers and Noise on Aircraft Structures; Distribution of Noise Sources Along a Jet; Ground Run-up Mufflers; Transmission of Sound from, and Acoustic Energy Flow in, a Moving Medium; Sound Generated by Interaction of a Vortex with a Shock Wave. (Contractor's abstract)

TOR.02:006

Toronto U. Inst. of Aerophysics (Canada).

MEASUREMENT OF TWO POINT CORRELATIONS OF THE SURFACE PRESSURE ON A CIRCULAR CYLINDER, by V. Prendergast. July 1958 [28]p. incl. diagrs. (UTIA Technical note no. 23) (AFOSR-TN-58-861) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)249 and Canadian Defence Research Board) AD 203674; PB 144739
Unclassified

Results of an experimental investigation of the two-point correlations of the surface pressure on a circular cylinder are presented. The cylinder was mounted in a wind tunnel at right angles to the flow and contained within it the two microphones which were used as pressure transducers. The curves of correlation coefficient vs hole spacing obtained did not follow the expected form, in that the correlation curves approached a constant value (approximately 0.2) rather than zero, as the hole spacing was increased to very large values. Three possible explanations are: (1) The measured results represent a true correlation. No theoretical explanation for such behavior is offered, beyond the suggestion that it may be a tunnel wall effect. (2) There is some fault in the experimental set-up or instrumentation. No such

TRL01:003, 004; TUF01:001, 002

fault could be discovered. (3) Vibration of the cylinder provides a coupling mechanism between the flow at points remote from one another. No evidence of such vibration was found. A correction involving a simple scale expansion has been employed to alter the form of the curves so that they approach zero at large hole spacings, which it is felt gives at least a good first approximation to the ideal free-field, rigid-cylinder correlation. Finally, employing the above assumption, a plot of correlation length vs Reynolds's number has been presented. (Contractor's abstract)

TRL01:003

Trinity Coll., Hartford, Conn.

THE CONVERGENCE OF SERIES OF CHARACTERISTIC FUNCTIONS OF THE DIFFERENTIAL OPERATOR $-d^2/dz^2 + z^N$, by W. J. Klimczak. Sept. 30, 1957, 13p. (AFOSR-TN-57-605) (AF 18(600)1397) AD 13651. Unclassified

The domain of absolute convergence $R(n)$ of power series $W = \sum_{n=0}^{\infty} w_n(z)$ in terms of the functions $w_n(z)$ which satisfy the differential operator $(-d^2/dz^2 + z^N)$ is investigated. The cases $n = 1, 2$ have been previously studied: when $n = 1$, the Airy series is absolutely convergent in the entire complex plane; and when $n = 2$, the resulting Hermite series converges absolutely for the values of z in the strip $-\infty < \text{Im}(z) < \infty$. The eigenvalue equation is solved to find the relationship between the power n and $R(n)$. It is found that there exists an infinite sequence of real eigenvalues such that $\lim_{n \rightarrow \infty} \lambda_n = \infty$.

The set of corresponding eigenfunctions is complete and orthogonal in $L^2(0, \infty)$. $R(n)$ is found to consist of the strip $-\tau < \text{Im}(z) < \tau$, such that $\tau = \lim_{n \rightarrow \infty} \sup (1/\sqrt{\lambda_n}) \cdot \log |f_n|$.

TRL01:004

Trinity Coll., Hartford, Conn.

REGULARITY PRESERVING FACTOR SEQUENCE TRANSFORMATIONS OF SERIES OF CHARACTERISTIC FUNCTIONS OF THE DIFFERENTIAL OPERATOR $-d^2/dz^2 + z^N$, by W. J. Klimczak. Nov. 30, 1958, 24p. (AFOSR-TN-58-1059) (AF 18(600)1397) AD 206990; PB 139083. Unclassified

Special types of regularity preserving factor sequence transformations are studied for series of the form

$$f(z) = \sum_{n=0}^{\infty} f_n w_n(z), \text{ where } w_n(z) \text{ are the characteristic functions of the second-order differential operator}$$

$\delta_z = z^N - d^2/dz^2$, N being a positive integer. Let $A = \{a_n\}$ denote a factor sequence and consider the series $F(z) = \sum_{n=0}^{\infty} a_n f_n w_n(z)$. If the ordinate of convergence of $F(z)$ is not less than that of $f(z)$, assumed to be positive, and if it is possible to continue $F(z)$ analytically along any finite path along which $f(z)$ can be continued, then the transformation $A[f(z)] = F(z)$ is a regularity preserving factor sequence transformation of $f(z)$. The conditions under which A is a regularity preserving transformation of $f(z)$ are studied. The theory of differential operators $G(\delta_z)$ are investigated, and the results are utilized for the study of some classes of regularity preserving factor sequence transformations of $f(z)$. (ASTIA abstract)

TUF01:001

Tufts U. Inst. for Applied Experimental Psychology, Medford, Mass.

HUMAN ENGINEERING BIBLIOGRAPHY 1955-1956, by E. V. Saul, A. W. Mills and others. Washington, Office of Naval Research, Oct. 1957, 1v. (ONR rept. no. ACR-24) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-49413) AD 149950; PB 131507. Unclassified

The purpose of this bibliography is to provide a useful compilation of references to the human engineering literature which reflects the most current acquisitions of the Human Information and Analysis Service. It is the first in a planned series of annual bibliographies in this field. Descriptive abstracts on the various phases of human engineering are provided.

TUF01:002

Tufts U. Inst. for Applied Experimental Psychology, Medford, Mass.

HUMAN ENGINEERING BIBLIOGRAPHY 1956-1957, by E. V. Saul, M. W. Raben and others. Washington, Office of Naval Research, Oct. 1958 [360]p. (ONR rept. no. ACR-32) (Sponsored jointly by Office of Naval Research and Air Force Office of Scientific Research under Nonr-49413) AD 205931; PB 131507S. Unclassified

Personnel responsible for the human factors considerations in the design and development of equipment have a major need for rapid and easy access to the literature pertinent to their work. The fact that the literature associated with human engineering derives from some 490 different journals and periodicals as well as a host of publications from governmental, industrial, and academic laboratories presents a compelling requirement for the development of useful bibliographic aids. This bibliography is one of a planned series of annual

TUS.01:003 - TUS.01:005

bibliographies of literature pertinent to human engineering which has been designed to meet this requirement. Two major considerations—ease of use and appropriate selection of material—strongly influenced this bibliography. As a result, five main parts exist: (1) a topical outline which defines over 300 topic headings established for this bibliography, (2) an index which associates the approximately 1400 bibliographic entries with the topic headings, (3) an alphabetic index of the common search terms which would aid those using this bibliography but who are unfamiliar with the topic headings, (4) an annotated bibliography of some 1400 citations, and (5) an index of the authors of these citations.

TUS.01:003

Tuskegee Inst. George Washington Carver Foundation,
Ala.

PREPARATION AND PROPERTIES OF ALPHA-FLUOROMETHYL ESTERS, by C. T. Mason. Oct. 1957, 14p. incl. tables. (AFOSR-TN-57-653) (AF 18-600)779) AD 136639 Unclassified

Various metal fluorides were tried as fluorine-for-chlorine exchange agents chloromethyl acetate. HgF_2 was found to be the most efficient of those tried. Petroleum ether (bp 40-45°) and Nujol were found to be the most useful solvents in the exchange reaction. No halogen exchange was observed when the fluorides of the following metals were refluxed with chloromethyl esters: aluminum, chromium, antimony, tin, and K. On the other hand, AgF and TlF were effective as exchange agents, but the temperature necessary for the reaction was so high that rapid decomposition and lower yields resulted. Some of the properties of the fluoromethyl esters are cited.

TUS.01:004

Tuskegee Inst. George Washington Carver Foundation,
Ala.

REACTIONS OF METALS WITH 1-ALKOXY-1-CHLOROETHANES AND CHLOROMETHYL ACETATES, by C. T. Mason. Oct. 1957, 8p. incl. tables. (AFOSR-TR-57-66) (AF 18(600)779) AD 136590 Unclassified

Metallic K reacted with alkoxychloromethanes and $\text{CH}_2\text{ClCHClOMe}$ uncontrollably to give tars from which no identifiable product could be isolated. With 1-butoxy-1-chloroethane, the reaction was easily controlled and BuOH, butyl acetal, and a small amount of high-boiling liquid were isolated. Acetal and the high-boiling component were obtained in the reaction of K with 1-

chloro-1-propoxyethane. Acetal, alkyl halide, and alcohol were the products of decomposition of 1-alkoxy-1-chloro-ethanes. Theories on the decomposition were postulated which agree with the experimental results and can be used for explaining the reactions of other metals with CH_3CHClOR . With heavier and less active

metals than Na and K, the reaction of the metal with the decomposition products from the 1-alkoxy-1-chloroethane were not vigorous enough to indicate that the metal was involved in the reaction. With alkoxychloromethanes, Na reacted to form the Wurtz product through an organosodium intermediate. Chloromethyl acetate reacted uncontrollably with Na in the absence of a solvent. With PhMe or benzene as a solvent, the reaction, if any, was very slow and most of the Na and chloromethyl acetate was recovered even after long refluxing. No apparent reaction resulted with Li, Zn, K, and Cu dust. Chloromethyl acetate reacted with a slight excess of BuMgCl to give a 55% yield of pentanol-1 and a higher-boiling compound.

TUS.01:005

Tuskegee Inst. George Washington Carver Foundation,
Ala.

PREPARATION AND PROPERTIES OF SOME CYCLIC ALPHA-FLUOROETHERS, by C. T. Mason. Nov. 1957, 15p. incl. tables, refs. (AFOSR-TR-57-91) (AF 18(600)779) AD 136726 Unclassified

Various chlorine derivatives of 1,4-dioxane, tetrahydrofuran, and thiophene were treated with metal fluorides, and attempts were made to isolate the fluoro derivative. For the most part, the observations made on previous preparations of alpha-fluoroalkyl ethers and esters seem to be true with the presently investigated cyclic compounds. An exchange reaction took place when HgF_2 was used as an exchange agent for the alpha-chlorine in dioxane and in tetrahydrofuran. The preparation of the fluoro derivative of thiophene is a complex reaction not simply one involving the exchange of fluorine for chlorine. The yields in the preparations of the alpha-fluoroethers are limited by the stability of the ethers. Multiple halogen on the same carbon or on adjacent carbon atoms lend stability to the compound. Fluorine atoms on adjacent carbon atoms give more stability than chlorine atoms in the same positions. Instability, particularly with the fluoroethers, is greatest when dehydrohalogenation is possible. It is extremely difficult to isolate an alpha-fluoroether when the fluorine is on a carbon attached to a carbon containing two hydrogen atoms. In general, the chemical properties of the fluorodioxanes seem to be similar to those of their chlorine analogues. The fluoro derivatives, on the basis of only a few reactions, are more reactive and less stable than their chlorine counterparts.

UPP.01:001; UPP.02:001-003

Universita di Roma (Italy) see Rome U. (Italy).Université d'Aix-Marseille. Institut de Mécanique des Fluides (France) see Marseille U. Inst. of Fluid Mechanics (France).Université Libre de Bruxelles (Belgium) see Free U. of Brussels (Belgium).

UPP.01:001

Uppsala U. Gustaf Werner Inst. of Nuclear Chemistry (Sweden).

RESEARCH ON "LOCALIZED RADIO-LESIONS."

PART I. THE EFFECT OF HIGH ENERGY PROTONS ON THE SPINAL CORD, by B. Larsson, L. Leksell and others. May 1, 1958, 11p. incl. refs. (AFOSR-TN-58-677) (AF 61(514)1247) AD 226788

Unclassified

Also published in Acta Radiologica, v. 51: 53-64, Jan. 1959.

The spinal cord in the rabbit has been irradiated with a 185 mev proton beam from a 230 cm synchrocyclotron. Using a 1.5 mm broad beam it has been possible to effect sharply delimited lesions of the spinal cord with only minimal hemorrhages and without any general reactions. With a 10 mm beam the tissue reactions are much more severe. The histopathology of the acute radiation necrosis is described and the factors responsible for its appearance are discussed, especially the width of the proton beam and the size of the single radiation dose. (Contractor's abstract)

UPP.02:001

Uppsala U. Inst. of Chemistry (Sweden).

THE STRUCTURES OF $\text{Ni}_6\text{Si}_2\text{B}$, Fe_2B AND SOME

RELATED PHASES, by S. Rundqvist and F. Jellinek. Oct. 20, 1958, 14p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-58-1019) (AF 61(052)40) AD 162284

Unclassified

Also published in Acta Chemica Scandinavica, v. 13: 425-432, 1959.

It has been found that the Fe_2P (C 22) structure previously proposed [S. B. Hendricks and P. R. Kesting, Zeitschr. Krist., v. 74: 511, 1930] must be revised. The true symmetry is hexagonal, rather than trigonal. The phases $\text{Ni}_6\text{Si}_2\text{B}$, Mn_2P , and Ni_2P are isotypic with Fe_2P , but Co_2P possesses a different - orthorhombic - structure. Some structurally related phases are also discussed. (Contractor's abstract)

UPP.02:002

Uppsala U. Inst. of Chemistry (Sweden).

X-RAY INVESTIGATIONS ON Me-Si-B SYSTEMS (Me=Mn,Fe-Co). I. SOME FEATURES OF THE Co-Si-B SYSTEMS AT 1000°C. INTERMEDIATE PHASES IN THE Co-Si-B AND Fe-Si-B SYSTEMS, by B. Aronsson and G. Lundgren. Oct. 20, 1958, 18p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-58-1020) (AF 61(052)40) AD 162285

Unclassified

Also published in Acta Chemica Scandinavica, v. 13: 433-441, 1959.

Some features of the Co-Si-B system at 1000°C have been determined with x-ray methods. It is found that the homogeneity ranges of the intermediate phases are small. The crystal structure of the ternary phase $\text{Co}_{4.7}\text{Si}_2\text{B}$ (isomorphous with $\text{Fe}_{4.7}\text{Si}_2\text{B}$) has been established from single crystal data and is closely related to the $\text{W}_5\text{Si}_3(\text{Tl})$ structure. The Fe-Si-B system contains several ternary phases, the most remarkable of which is a cementite (Fe_3C) type phase, while the crystal structures of Fe_5SiB_2 and Mn_5SiB_2 are shown to be of the $\text{Cr}_5\text{B}_3(\text{T2})$ type. (Contractor's abstract)

UPP.02:003

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF Ru_7B_3 , by B. Aronsson. [1958] [12]p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-58-1090) (AF 61(052)40) AD 207587; PB 142588

Unclassified

Also published in Acta Chemica Scandinavica, v. 13: 109-114, 1959.

The crystal structure of Ru_7B_3 has been determined from single crystal data. There are two formula units in the unit cell, determined to be hexagonal with $a = 7.467\text{\AA}$ and $c = 4.713\text{\AA}$. The space group is $\text{P6}_3\text{mc}$.

The ruthenium atoms are situated in two six-fold positions 6 (c) with $x_1 = 0.4563$, $x_2 = 0.318$, and $x_{\text{II}} = 0.1219$, $x_{\text{II}} = 0.000$ and one two-fold position 2(b) with $x_{\text{III}} = 0.818$. The structure of Ru_7B_3 is very closely related to that of the trigonal chromium carbide Cr_7C_3 . (Contractor's abstract)

UPP.03:001 - UPP.03:005

UPP.03:001

Uppsala U. Inst. of Physics (Sweden).

A DECAY OF A NEGATIVE τ' , by S. Nilsson. [1957] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 61(514)1015, phase A] and Swedish [Atomic Committee])

Unclassified

Published in Nuclear Phys., v. 3: 364-366, May 1957.

An event was observed in a stack of plates exposed to the partially separated K-meson beam at the Berkeley bevatron which is consistent with the decay in flight of a negative τ' meson: $\tau' \rightarrow \pi^- + \pi^0 + \pi^0$. Thus, the negative K-meson decay modes so far observed include the $K_{\pi^2}^-$, K_{e3}^- , τ^- and the negative τ' .

UPP.03:002

Uppsala U. Inst. of Physics (Sweden).

THE INFLUENCE OF I-FORBIDDENNESS ON MAGNETIC DIPOLE TRANSITIONS IN Tl^{203} , by T. Lindqvist and I. Marklund. [1957] [8]p. incl. diagrs. tables, refs. [AF 61(514)1015, phase B]

Unclassified

Published in Nuclear Phys., v. 3: 367-374, May 1957.

The angular correlation of the 400 kev - 270 kev cascade in Tl^{203} has been measured. The correlation function has the form $w(\theta) = 1 - (0.205 \pm 0.005) \cos^2 \theta$. A comparison between the mixing ratio of the 400 kev transition ($d_{5/2} - d_{3/2}$) and the mixing ratio of the 270 kev transition ($d_{3/2} - s_{1/2}$) is done. The I-forbidden M1 transition is retarded by a factor of 1.3×10^{-3} compared to the I-allowed M1 transition.

UPP.03:003

Uppsala U. Inst. of Physics (Sweden).

MIXING RATIOS OF $2^+ - 2^+$ TRANSITIONS IN SOME EVEN NUCLEI, by T. Lindqvist and I. Marklund. [1957] [17]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 61(514)1015, phase B] and Swedish Atomic Committee)

Unclassified

Published in Nuclear Phys., v. 4: 189-205, Aug. 1957.

Mixing ratios of $2^+ - 2^+$ transitions in Se^{76} , Te^{122} , Te^{124} , and Os^{186} have been measured by means of directional gamma-gamma correlations. Ten other

similar cases in even nuclei have been summarized. The E2 radiation is dominating, although the amount of M1 radiation is measurable. The investigated transitions are examples of transitions between vibrational states, which according to theory should proceed by pure E2. The presence of M1 might indicate that the wave functions involved are not pure. The possibility of emission of EO conversion electrons has been discussed. In six cases an upper limit has been given for the emission rate. (Contractor's abstract)

UPP.03:004

[Uppsala U. Inst. of Physics (Sweden).]

APPLICATIONS OF A MULTI-CHANNEL GONIOMETER, by T. Lindqvist and E. Karlsson. [1957] [18]p. incl. illus. diagrs. tables, refs. [AF 61(514)1015, phase B]

Unclassified

Published in Ark. Fys., v. 12: 519-536, 1957.

A multi-channel goniometer (MCG) for gamma-gamma angular correlation measurements is described. The apparatus has 4 channels. Various methods of measurement and a complete treatment of data are given. The MCG has been carefully tested with well known correlations (Bi^{207} , Hf^{181} and Co^{60}). As applications, the angular correlations of gamma cascades from Ba^{131} and Nd^{147} have been investigated. Both cases involve I-forbidden magnetic dipole transitions. From the mixing ratios determined in the correlation experiments it is possible to estimate the strength of forbiddenness.

An upper limit of the g-factor of the 92 kev level in Pm^{147} is determined by studying the influence of a magnetic field on the angular correlation. (Contractor's abstract)

UPP.03:005

Uppsala U. Inst. of Physics (Sweden).

Be^7 CONTENT IN SNOW, by R. Nilsson, K. Siegbahn and others. [1957] [7]p. incl. diagrs. tables. [AF 61(514)1015, phase B]

Unclassified

Published in Ark. Fys., v. 11: 445-451, 1957.

The radioactive isotope Be^7 , which is produced in the atmosphere by cosmic radiation, has been extracted from collected snow samples by means of ion exchange.

The intensity of the Be^7 radiation has been measured with a scintillation spectrometer. The average concentration of Be^7 atoms in the three snow samples was 4.3×10^3 atoms/cm³ (volume of water). (Contractor's abstract)

UPP.03:006 - UPP.03:010

UPP.03:006

Uppsala U. Inst. of Physics (Sweden).

THE DECAY OF THE ISOTOPES $Au^{191-196}$, by G. Bäckström, O. Bergman and others. [1957] [4]p. incl. tables. (Bound with its AFOSR-TR-58-26; AD 152201) [AF 61(514)1015, phase B] Unclassified

The decay of $Au^{191-193}$ has been comparatively little studied, probably because of the short half-lives and the high bombarding energy necessary to produce these isotopes. The samples used in this investigation have been produced by irradiating a Pt foil with 60 mev protons at the synchro-cyclotron, Uppsala. After chemical separation the carrier-free Au was collected on a thin silver layer, constituting an almost ideal source. The data found concerning these isotopes, of half-lives 30^h , 5^h and 15^h respectively, are very preliminary, and no attempt to establish decay schemes has yet been done. The 30^h and 15^h activities show a very rich low energy spectrum, whereas the levels of Pt^{192} seem to be more widely spaced. Efforts have been concentrated on the extremely complicated decay $Au^{194} - Pt^{194}$. The decay is being studied by means of three instruments: the iron free double focusing spectrometer up to about 100 kev, its iron pole equivalent up to 3 mev and the double lens spectrometer for e-e coincidences. There is evidence for about 100 γ -conversion lines belonging to Pt^{194} , but this number is expected to increase. The decay of $Au^{196} - Pt^{196}$ is very simple, proceeding through two excited states. The energies for the cascade γ -transitions are 0.33285 mev and 0.35580 mev. The E 2 cross-over has been found to be about an order of magnitude more forbidden than in other even-even nuclei in this region.

UPP.03:007

Uppsala U. Inst. of Physics (Sweden).

GAMMA TRANSITIONS IN $As^{76} - Se^{76}$, by G. Bäckström. [1957] [2]p. incl. diagrs. table. (Bound with its AFOSR-TR-58-26; AD 152201) [AF 61(514)-1015, phase B] Unclassified

In order to check the consistency of the present decay scheme of As^{76} , an investigation was made of the γ -lines using a double focusing spectrometer. The following energies and intensities were found: 0.5591 ± 2 (1), 0.6571 ± 2 (0.20), 1.2159 ± 4 (0.17) and 1.2290 ± 6 (0.04). A new feature of the decay was a splitting of the 1.20 mev line, which was fully established as a line belonging to the decay of As. The investigation showed that the strongest component of the doublet was the one

that paralleled the 0.66 - 0.56 mev cascade. Work is in progress to establish the place of the new transition, and at present it may be regarded as an indication for a level between 1.22 and 2.59 mev.

UPP.03:008

Uppsala U. Inst. of Physics (Sweden).

ANTIPROTONS IN NUCLEAR EMULSIONS, by A. G. Ekspong, S. Johansson, and B. E. Ronne. [1958] 17p. incl. diagrs. tables. (AFOSR-TN-58-82) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1015 and Swedish [Atomic Committee] Unclassified

Also published in Nuovo Cimento, Series X, v. 8: 84-91, Apr. 1, 1958.

A stack of nuclear emulsions have been exposed at the Berkeley Bevatron, in which 10 events have been identified as due to antiprotons. The interaction characteristics have been analyzed and are reported. Of special interest is the observation of an elastic collision between an antiproton and a free proton. (Contractor's abstract)

UPP.03:009

Uppsala U. Inst. of Physics (Sweden).

ANTIPROTONS IN NUCLEAR EMULSIONS, by A. G. Ekspong, S. Johansson, and B. E. Ronne. [1958] 1v. incl. diagrs. tables. (AFOSR-TR-58-25) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1015, phase A and Swedish [Atomic Committee] AD 152200; PB 138491 Unclassified

Investigations were made of the properties and behavior in matter of antiprotons and negative K-mesons. By using the bevatron as the particle source, one large stack of nuclear research plates were exposed to antiprotons, while two stacks were exposed to K-mesons. The antiproton stack, consisting of 120 pellicles 4 x 7 in. in size, was scanned twice, yielding a total of 10 antiprotons. Two associated problems investigated were (1) the decay products of the negative K-mesons, in which the existence of the π^0 mode of decay among the negative K-particles is established; and (2) the nature and energy of the interaction products. (ASTIA abstract)

UPP.03:010

Uppsala U. Inst. of Physics (Sweden).

[RADIOACTIVE ISOTOPE PROJECT] Technical rept. Sept. 1, 1956-Aug. 31, 1957, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-26) (AF 61(514)1015, phase B) AD 152201; PB 140918 Unclassified

UPP.03:011; UPP.04:001-003

A resume is given of the scientific investigations made in measuring radiations from radio-isotopes of high specific activity by means of various devices including beta- and gamma-ray spectrometers. This paper also includes the following reports: (1) An Atomic Beam Resonance Apparatus with Focusing Six-Pole Magnets. Measurements on Some Bismuth Isotopes, by I. Lindgren and M. Johansson; (2) The Decay of the Isotopes Au^{191} - Au^{196} , by G. Bäckström, O. Bergman and others; (3) Gamma Transitions in As^{76} - Se^{76} , by G. Bäckström; (4) The Influence of l-Forbiddenness on Magnetic Dipole Transitions in Tl^{203} , by T. Lindqvist and I. Marklund; (5) Be^{76} Content in Snow, by R. Nilsson, K. Siegbahn and others; (6) The Internal Compton Effect, by T. Lindqvist, B.-G. Pettersson, and K. Siegbahn; (7) Mixing Ratios of $2^+ - 2^+$ Transitions in Some Even Nuclei, by T. Lindqvist and I. Marklund; and (8) Applications of a Multi-Channel Goniometer, by T. Lindqvist and E. Karlsson.

UPP.03:011

Uppsala U. Inst. of Physics (Sweden).

THE INTERNAL COMPTON EFFECT. A DETERMINATION OF CROSS SECTION AND ANGULAR CORRELATION, by T. Lindqvist, B.-G. Pettersson, and K. Siegbahn. [1958] [11]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 61(514)1015, phase B] and Swedish Atomic Committee) Unclassified

Published in Nuclear Phys., v. 5: 47-57, Jan. 1958.

The internal Compton effect, a nuclear transition in which there is a simultaneous ejection of a bound electron and emission of a gamma ray, has been unambiguously demonstrated. The experiment concerned the 662 kev transition in Ba^{137m} and was carried out with a gamma scintillation spectrometer and a beta-ray spectrometer in coincidence. The presence of other effects was carefully considered. The experimental cross section was found to be 1.86×10^{-5} photons in the energy region 97 kev - 120 kev per conversion electron at 90° between the electron and photon directions. Angular correlation experiments were carried out. Comparison with various theories shows that the theory by Spruch and Goertzel does fit the experimental results excellently both regarding absolute cross section and angular correlation. (Contractor's abstract)

UPP.04:001

Uppsala U. Inst. of Physics (Sweden).

ANTIPROTON INTERACTIONS, by A. G. Ekspong and

B. E. Ronne. [1958] [8]p. incl. diagrs. tables. (Technical note no. 1) (AFOSR-TN-58-878) (AF 61(052)13, phase A) AD 203910 Unclassified

Intermediate results of the search of photographic emulsions for antiproton interactions are reported. The annihilation cross section for the antiproton in the emulsion and average mean free path length are given. Data on 6 events of p-p̄ elastic scattering and 4 events of inelastic p̄ scattering from complex nuclei are presented. (See item nos. UPP.03:008 and UPP.04:004.)

UPP.04:002

Uppsala U. Inst. of Physics (Sweden).

K^- INTERACTIONS IN FLIGHT, by A. Frisk and S. Nilsson. [1958] 6p. incl. diagr. tables, refs. (Technical note no. 2) (AFOSR-TN-58-879) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)13, phase A and Swedish [Atomic Committee]) AD 203909; PB 136865 Unclassified

Also published in Ark. Fys., v. 14: 277-292, 1958. (Title varies)

A total track length of 41 m of K^- mesons has been measured in the energy interval 0-140 mev and 208 interactions in flight have been analyzed to yield the total cross section per nucleus in emulsion $\sigma = 780 \pm 60$ mb. The corresponding average total nucleon cross section in nuclear matter is calculated to be $\bar{\sigma} = 80 \pm 15$ mg. The mean free path $\lambda = 0.95 \times 10^{-13}$ cm implies a large absorptive potential ~ 60 mev. The derived limits on the free neutron cross sections do not contradict the assumption that charge independence holds in the absorption and scattering processes. The differential cross section for elastic scattering between 5° - 30° is given. An attractive K^- nuclear potential is inferred from the percentage of reemerging K^- mesons. (Contractor's abstract)

UPP.04:003

Uppsala U. Inst. of Physics (Sweden).

DECAY MODES AND LIFETIME OF NEGATIVE HEAVY MESONS, by S. Nilsson and A. Frisk. [1958] [18]p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-58-880) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)13, phase A and Swedish Atomic [Committee]) AD 203908; PB 136741 Unclassified

Also published in Ark. Fys., v. 14: 293-302, 1958.

The relative abundances of the different decay modes have been obtained from 21 events representing possible decays of the negative K meson. Events consistent with τ^- and μ^- and β decay modes of K^- meson decays have been observed. The percentage of nuclear reactions

UPP.04:004 - UPP.04:007

among the events with one charged secondary was found to be about 20%. The mean lifetime of the K⁻ was found to be 1.50×10^{-8} sec with uncertainty of ± 0.45 and -0.30×10^{-8} sec. Three τ^- events were observed and a mass 494.4 ± 1.2 mev was obtained. (Contractor's abstract, modified)
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UPP.04:004

Uppsala U. Inst. of Physics (Sweden).

[RADIOACTIVE ISOTOPE PROJECT] Technical rept. Sept. 1, 1957-Sept. 1, 1958, 1v. incl. diagrs. tables, refs. (AFOSR-TN-58-1077) (AF 61(052)13, phase A) AD 207456; PB 150694
Unclassified

A resumé is presented of the experimental work previously performed under contracts AF 61(514)1015 and AF 61(052)13, phase A on antiproton experiments and K⁻ interactions. Included are a series of reports issued under these contracts: Antiprotons in Nuclear Emulsions (item no. UPP.03:008), Interactions in Flight (item no. UPP.04:002), Emission of Charged Σ^+ and Π from K⁻-proton Capture in Nuclear Emulsions (item no. UPP.04:014), Decay Modes and Lifetime of Negative Heavy Mesons (item no. UPP.04:003), and Antiproton Interaction Cross Sections (AFOSR-TN-59-412).

UPP.04:005

Uppsala U. Inst. of Physics (Sweden).

[RADIOACTIVE ISOTOPE PROJECT] Technical rept. Sept. 1, 1957-Aug. 31, 1958, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-1078) (AF 61(052)13, phases B and C) AD 207457
Unclassified

The status of the research accomplished under phases B and C of contract AF 61(052)13 during the period Sept. 1, 1957 to Aug. 31, 1958 is reported. Phase B includes research to measure radiations from radioisotopes of high specific activity by means of β - and γ -ray spectrometers. The following reports are included:

Contributions to the Decay of Tb^{160} to Dy^{160} (item no. UPP.04:013), On Helicity of Neutrinos (item no.

UPP.04:011), Decay of Eu^{152m} (item no. UPP.04:010), Evidence for the Presence of E0 in Direct Competition with M1 and E2 (item no. UPP.04:006), Measurements on the v/c Dependence of the Beta-Circularly Polarized

Gamma Correlation in Co^{60} Using a Magnetic Lens Spectrometer (item no. UPP.04:015), Atomic Beam Measurements (item no. UPP.04:012), Transitions in

Hg^{199} Following the Decay of Au^{199} (item no. UPP.04:007), Some Features of the Decay of Au^{198} to Hg^{198}

(item no. UPP.04:018), Atomic Beam Resonance Apparatus With Six-Pole Magnets for Radioactive Isotopes

(item no. UPP.04:009). Phase C includes research for building an x-ray spectrometer for studying small angle scattering of point focusing, monochromatic radiation. The following reports are included: Point Focusing for Studying Small-Angle Scattering of X-Rays (item no. UPP.04:016), and Small-Angle Scattering of X-Rays (item no. UPP.04:017).

UPP.04:006

Uppsala U. Inst. of Physics (Sweden).

EVIDENCE FOR THE PRESENCE OF E0 IN DIRECT COMPETITION WITH M1 AND E2, by T. R. Gerholm and B. G. Pettersson. [1958] 9p. incl. tables, refs. (Bound with its AFOSR-TN-58-1078; AD 207457) (Sponsored jointly by Air Force Office of Scientific Research under [AF 61(052)13, phases B and C] and Swedish Atomic [Committee])
Unclassified

Also published in Phys. Rev., v. 110: 1119-1122, June 1, 1958.

Gamma-electron and electron-gamma angular directional correlation measurements have been obtained for the $334.0 - 356.5$ kev cascade in Pt^{196} using a beta-spectrometer and a NaI(Tl) scintillation detector. The result obtained for the A_2 term in the gamma-electron case is in agreement with earlier gamma-gamma measurements by Steffen. The electron-gamma A_2 term gives evidence for admixtures due to electric monopole internal conversion as predicted by Church and Weneser. (Contractor's abstract.)

UPP.04:007

Uppsala U. Inst. of Physics (Sweden).

TRANSITIONS IN Hg^{199} FOLLOWING THE DECAY OF Au^{199} , by G. Bäckström, O. Bergman, and J. Burde. [1958] [13]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)13, phases B and C]
Unclassified

Published in Nuclear Phys., v. 7: 263-275, June 1958.

The energies of the three γ -lines in Hg^{199} have been measured on an absolute energy scale using an iron-free double focusing spectrometer. The atomic binding energy was also absolutely determined. Relative L-subshell conversion intensities were found to yield accurate information on the multipolarity. Relative M-shell conversion coefficients were compared with theory. Partial transition probabilities were computed, and the effect of Δ -forbiddenness was studied. (Contractor's abstract.)

UPP.04:008 - UPP.04:013

UPP.04:008

Uppsala U. Inst. of Physics (Sweden).

PROTONIC Σ -DECAY WITH AN ASSOCIATED ELECTRON PAIR, by A. G. Ekspong and S. Nilsson. [1958] [3]p. incl. diagr. table. [AF 61(052)13, phase A]

Unclassified

Published in Phys. Rev. Letters, v. 1: 36-38, July 1, 1958.

An unusual example of protonic Σ -decay with an associated electron pair is reported. The event is direct evidence of the π^0 in the $\Sigma + p$ decay but the explanation in terms of the alternative Dalitz mode of decay of the π^0 is not entirely satisfactory. Various possibilities for the decay mode are considered.

UPP.04:009

Uppsala U. Inst. of Physics (Sweden).

ATOMIC BEAM RESONANCE APPARATUS WITH SIX-POLE MAGNETS FOR RADIOACTIVE ISOTOPES, by I. Lindgren. [1958] 16p. incl. illus. diagrs. refs. (Bound with its AFOSR-TN-58-1078; AD 207457) (Sponsored jointly by Air Force Office of Scientific Research under [AF 61(052)13, phases B and C] and Swedish Atomic Committee)

Unclassified

Also published in Nuclear Instruments, v. 3: 1-16, July 1958.

The principles of the construction design and of calculations for the maximizing of the intensity of an atomic beam resonance apparatus with focusing six-pole magnets for measurements of spins and magnetic moments of radioactive nuclei is presented. The effective solid angle, averaged over the velocity distribution of the beam, has been calculated to be about 3×10^{-4} steradians in a typical case, which is one order of magnitude larger than can be obtained by the conventional method. The apparatus has been used for measurements on four radioactive bismuth isotopes which has been reported in Nuclear Phys., v. 9: 44, Nov. 1958. (Contractor's abstract, modified)

UPP.04:010

Uppsala U. Inst. of Physics (Sweden).

DECAY OF Eu^{152m} , by I. Marklund. [1958] [7]p. incl. diagr. tables, refs. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)13, phases B and C]

Unclassified

Also published in Nuclear Phys., v. 9: 83-87, Nov. 1958.

The decay of the metastable state of Eu^{152} with a half-

life of 9.2h into Sm^{152} and Gd^{152} has been investigated by means of coincidence experiments. The gamma energies and intensities are measured with a crystal spectrometer and a double focusing iron yoke spectrometer. A three level decay scheme to Gd^{152} and a four level decay scheme to Sm^{152} are presented.

UPP.04:011

Uppsala U. Inst of Physics (Sweden).

ON HELICITY OF NEUTRINOS, by I. Marklund and L. A. Page. [1958] [10]p. incl. diagrs. refs. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)-13, phases B and C]

Unclassified

Also published in Nuclear Phys., v. 9: 88-93, Nov. 1958.

In order to determine the helicity of neutrinos, measurement was made of the sign and magnitude of polarization of γ -rays emitted in opposite direction to the neutrinos. The 963 kev γ -ray following electron-capture by Eu^{152m} is thus measured to be $80 \pm 30\%$ circularly polarized with negative helicity. This result is in agreement with the measurement and conclusion by Goldhaber that the emitted neutrino has negative helicity, $\sigma, p = -1$, in this orbital electron capture. (Contractor's abstract)

UPP.04:012

[Uppsala U. Inst. of Physics (Sweden)]

ATOMIC BEAM MEASUREMENTS, by I. Lindgren and M. Johansson. [1958] 2p. incl. table. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)13, phases B and C]

Unclassified

Partial results are reported on the use of a six-pole focusing atomic beam resonance apparatus for the measurement of nuclear spins, magnetic dipole moments and electric quadrupole moments of 6 Bi isotopes. Experiments on Tl^{201} are in progress, and the spin of this isotope has been reported as $\frac{1}{2}$. (See item no. UPP.04:009 and Nuclear Physics, v. 9: 44, Nov. 1958.)

UPP.04:013

Uppsala U. Inst. of Physics (Sweden).

CONTRIBUTIONS TO THE DECAY OF Tb^{160} TO Dy^{160} , by G. Bäckström, J. Lindskog and others. [1958] [12]p. incl. diagrs. tables. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)13, phases B and C]

Unclassified

Also published in Ark. Fys., v. 15: 121-129, 1959.

A reinvestigation of the internal conversion spectrum

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and the photoelectron spectrum of the decay of Tb^{160} into Dy^{160} has been carried out by means of an (e,e) coincidence spectrometer. Three new transitions in the energy range from 1115 to 1312 keV have been discovered. Energy levels at 1399 and 1199 keV have been considered in order to account for these transitions.

UFP.04:014

Uppsala U. Inst. of Physics (Sweden).

EMISSION OF CHARGED $\Sigma + \Pi$ FROM K^- -PROTON CAPTURE IN NUCLEAR EMULSIONS, by S. Nilsson and A. Frisk. [1958] [12]p. incl. diagrs. table. [AF 61(052)13, phase A] Unclassified

Published in Ark. Fys., v. 14: 303-314, 1958.

A group of 100 two-prong stars from the reaction $K + p \rightarrow \Sigma + \pi$ have been analyzed and 52 of these events were found to be compatible with captures on bound and free protons. A comparison between the experimental and expected hyperon energy distribution, using a degenerate Fermi gas model of the nucleus, gives a best fit for an attractive real Σ -nuclear potential of 25 meV. An average Coulomb potential of the capturing nucleus of 8 ± 2 meV is deduced. The fraction of zero prong Σ^- -stars is 0.66 ± 0.10 . The Σ^- -mass has been found to be 1196.7 ± 0.6 meV from three K^- capture events on free protons. (Contractor's abstract, modified)

UFP.04:015

Uppsala U. Inst. of Physics (Sweden).

MEASUREMENTS ON THE v/c -DEPENDENCE OF THE BETA-CIRCULARLY POLARIZED GAMMA CORRELATION IN Co^{60} USING A MAGNETIC-LENS SPECTROMETER, by L. A. Page, B.-G. Pettersson, and T. Lindqvist. [1958] [6]p. incl. diagrs. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)13, phases B and C] Unclassified

A γ - e^- coincidence apparatus has been used for measurements on the v/c dependence of the correlation between e^- and circularly polarized γ rays. In this way the beta momentum has been rigorously defined by means of a magnetic-lens spectrometer rather than relying on pulse height discrimination. The experimental results which indicate a constant 33% right circular polarization for all values of v/c are in rather sharp disagreement with the predicted linear dependence of the polarization on v/c given as 0.33 v/c at 180° .

UFP.04:016

[Uppsala U. Inst. of Physics (Sweden).]

POINT FOCUSING APPARATUS FOR STUDYING SMALL-ANGLE SCATTERING OF X-RAYS, by K. Siegbahn. [1958] [9]p. incl. illus. diagrs. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)13, phases B and C] Unclassified

Published in Ann. Acad. Regiae Scientiarum Upsaliensis, v. 2: 102-110, 1958.

An x-ray spectrometer which is used to study the small angle diffraction has been developed by the use of a pair of spherically bent crystals. The spectrometer is used at large Bragg angles so that the spherical surface approximates a toroidal surface which would produce a true point focus. Large dispersion and low anastigmatic aberration are possible for the monochromatic beam. Preliminary diffraction studies have been carried out on polystyrene latex particles.

UFP.04:017

[Uppsala U. Inst. of Physics (Sweden).]

SMALL-ANGLE SCATTERING OF X-RAYS, by G. Wassberg and K. Siegbahn. [1958] 15p. incl. illus. diagrs. tables, refs. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)13, phases B and C] Unclassified

Published in Ark. Fys., v. 14: 1-15, 1958.

The construction and use of an x-ray spectrometer which employs two spherically bent crystals is described. The spectrometer has achieved anastigmatic two-dimensional focusing of the monochromatic beam and has reduced the exposure time as compared with previous spectrometers thus making possible the study of scattering at small angles. The theory of scattering at small angles of x-rays from single spherical particles and agglomerates of spherical particles is presented. Experimental results of scattering from polystyrene latex particles of size 3400 Å are found to deviate from expected results in the positioning of the first few diffraction maxima.

UFP.04:018

Uppsala U. Inst. of Physics (Sweden).

SOME FEATURES OF THE DECAY OF Au^{198} TO Hg^{198} , by G. Bäckström and O. Bergman. [1958] [5]p. incl. diagrs. (Bound with its AFOSR-TN-58-1078; AD 207457) [AF 61(052)13, phases B and C] Unclassified

UTA.01:008 - UTA.01:011

Published in Ark. Fys., v. 13: 393-397, 1958.

It is found that Hg^{198} emits gamma rays of energies 0.67575 mev and 1.0875 mev in decaying from its second excited state. A splitting of this state, which has recently been reported elsewhere, is not observed. The β -branching to a state at 1.000 mev, observed in the decay of metastable Ti^{198} is shown to be weaker than theoretically expected. (Contractor's abstract)

UTA.01:008

Utah U. Dept. of Electrical Engineering, Salt Lake City.

A VECTOR ANALYSIS OF A SOLENOID-TYPE ELECTROMAGNETIC ACCELERATOR, by B. E. Bona and L. D. Harris. May 1957, 37p. Incl. illus. diagrs. tables, refs. (Technical rept. no. 8) (AFOSR-TN-57-292) (AF 18(600)1217) AD 132363 Unclassified

An analysis is presented of a one-stage or single-solenoid accelerator. The solenoid-type accelerator consists of a hollow coil in which a conducting projectile is placed. Energy is supplied to the solenoid by discharging a capacitor bank through it. The voltages induced in, and the forces acting on the projectile are analyzed from a vector approach. To simplify the analysis, the projectile is thought of as being a single loop conductor. The current in the projectile is eliminated from a set of parametric equations, and a second-order differential equation in velocity results. An approximate solution to this equation is obtained for 2 values of projectile resistance. A picture of an accelerated projectile is shown for establishing the validity of the differential equation. The maximum obtainable velocity from the solenoid-type accelerator is a function of the circuit frequency and of the projectile length. The inductance of the solenoid and the capacitance of the energy source are more important parameters than the projectile length. The temperature rise which occurs in the projectile seriously limits the possibility of constructing such a high-velocity accelerator.

UTA.01:009

Utah U. Dept. of Electrical Engineering, Salt Lake City.

AN INVESTIGATION OF CRATERS FORMED BY HIGH-VELOCITY PELLETS, by W. S. Partridge, H. B. VanFleet, and C. R. Whited. May 1957, 45p. Incl. illus. refs. (Technical rept. no. 9) (AFOSR-TN-57-293) (AF 18(600)1217) AD 132364 Unclassified

High-velocity-impact studies were conducted in which Zn, Sn, Cu, Pb, Al, and Fe spheres were accelerated to velocities of 0.75 to 2.25 km/sec and then impacted normally upon targets of the same material. Conditions were maintained so that the pellet lost no mass before striking the target. The target mass was large in comparison with that of the pellet so that they could

be considered semi-infinite. A correlation between crater volume, depth, and cross-sectional area to the energy and momentum of the pellet and parameters of the different metals is presented. The volume of a crater produced by a high-velocity pellet of the same material was found to be directly proportional to the kinetic energy of the pellet. The penetration varied linearly with the velocity over the velocity range and materials investigated. This relationship is compared with the one suggested by Huth (Jour. Appl. Mechanics, v. 64: 65, Mar. 1957). Results showed that the area of the crater is directly proportional to the kinetic energy of the pellet for the metals listed over the energy range under consideration.

UTA.01:010

Utah U. Dept. of Electrical Engineering, Salt Lake City.

PROJECTILE DECELERATION BY ELECTROMAGNETIC FIELDS, by L. D. Harris and L. E. Jenkins. May 1957, 43p. Incl. diagrs. tables. (Technical rept. no. 10) (AFOSR-TN-57-294) (AF 18(600)1217) AD 132365 Unclassified

A comprehensive statement of the general theory of decelerating projectiles with electromagnetic fields is followed by a detailed analysis of the individual components that contribute to the retarding force. An experimental verification was made of calculations of the retarding forces on a 50-cal machine gun bullet fired through a 0.073-m-long solenoid, with a 0.009-m radius; the solenoid consisted of 90 turns wound in 2 layers. Almost a 5000-amp current was flowing through the solenoid when the projectile was passing through. The calculations indicate a deceleration of 28 m/sec, while the tests resulted in a deceleration of an average of 43 m/sec. This represents a 3.2% deceleration according to calculations and a 4.2% deceleration according to test results.

UTA.01:011

Utah U. Dept. of Electrical Engineering, Salt Lake City.

LADDER AND SIMILAR NETWORKS USED FOR PROJECTILE ACCELERATION BY ELECTROMAGNETIC METHODS, by L. D. Harris and D. S. Humphreys. May 1957, 77p. Incl. illus. diagrs. tables. (Technical rept. no. 11) (AFOSR-TN-57-301) (AF 18(600)1217) AD 132372 Unclassified

The efficiency of the electromagnetic acceleration of projectiles can be increased by using 2 stages of acceleration. The first accelerator consists of a large capacity, high-voltage condenser which discharges through a very low inductance coil. The charging currents in the coil produce eddy currents in the pellet which react with the radial component of the flux to produce the accelerating force. With a 2-stage accelerator the current

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in the second coil must be zero (or very small) until the pellet reaches its center, at which point the current must build up rapidly to provide another stage of acceleration. The period of zero current in the second coil is called the time delay; its magnitude depends upon the speed of the pellet and the distance it must travel. A simple 2-mesh RC circuit and a multiple-mesh ladder network are theoretically and experimentally investigated for the current configurations and possible delays produced. Results indicate that (1) a basic 2-mesh circuit is practical for velocities about twice those presently available, (2) a modification of the basic circuit (a coil is tightly coupled to the first accelerating coil after being added to the shunt leg in series with the second capacitor) would provide a time delay more compatible with present velocities, and (3) the ladder can be used when extremely high velocities are obtained although at slow speeds it is very expensive and inefficient.

UTA-01:012

Utah U. Dept. of Electrical Engineering, Salt Lake City.

A MULTI-STAGE ELECTROMAGNETIC ACCELERATOR MODEL, by A. S. Jones and L. D. Harris. Sept. 1957, 30p. incl. illus. diagrs. refs. (Technical rept. no. 12) (AFOSR-TN-57-551) (AF 18(600)1217) AD 136535 Unclassified

A multi-stage electromagnetic accelerator was made from a number of short solenoid coils spaced axially along a plastic tube running through their centers. The projectile used was a hollow aluminum cylinder whose length was slightly less than one half the length of the coil. An electronic system discharged a capacitor into each coil at the appropriate time. The frequency of the current in each coil was varied while the energy supplied to the coil was held constant. It was found that each stage had an optimum frequency for maximum transfer of energy to the projectile. If each stage operated at its own optimum frequency, the efficiency of conversion of stored electrical energy to kinetic energy in the projectile was the same for each stage. This efficiency was found to be slightly less than five per cent. (Contractor's abstract)

UTA-01:013

[Utah U. Dept. of Electrical Engineering, Salt Lake City]

SOME NEW DATA ON HIGH-SPEED IMPACT PHENOMENA, by J. H. Huth, J. S. Thompson, and M. E. Valkenburg. [1957] [4]p. incl. diagrs. [AF 18(600)-1217] Unclassified

Presented at annual meeting of the Amer. Soc. Mech. Engineers, New York, Nov. 25-30, 1956.

Published in Jour. Appl. Mech., v. 24: 65-68, Mar. 1957.

A summary is presented of some recent experimental work aimed at evaluating the role of various physical parameters in high-speed impact phenomena. It is shown that penetration into thick targets by projectiles of the same material, for certain common metals, can be expressed approximately through a single relationship of the form $(p/d) = 2.5(V/c)^{1.4}$ in a range of about $0.1 \leq (V/c) \leq 1.0$. Here p represents penetration (crater depth) measured from the initial target surface, d a characteristic dimension of the projectile, and V , the impact velocity. c is the "sonic" velocity in the projectile and target material as expressed by the formula $c = \sqrt{E/\rho}$, where E is Young's modulus and ρ the density. Experimental results are given for steel, aluminum, brass, lead, magnesium, and a magnesium-lithium alloy. (Contractor's abstract)

UTA-01:014

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

THE COIL TYPE OF ELECTROMAGNETIC ACCELERATOR, by L. D. Harris. [1957] [5]p. incl. illus. diagr. table. [AF 18(600)1217] Unclassified

Published in Proc. Second Hypervelocity and Impact Effects Symposium, Washington, D. C. (May 22-24, 1957), Washington, Naval Research Lab., v. 1: 163-167, Dec. 1957.

An analysis is presented of the quantity of energy transferred from the accelerating coil of gun to the pellet projectile in terms of the coil current, pellet inductance and the mutual inductance of the system. An experimental single-stage electromagnetic gun has been constructed which is capable of accelerating a 4.5 gm aluminum pellet to a final velocity of 200 m/sec. A projection of system changes required to build a gun which would produce 10 km/sec particles is given.

UTA-01:015

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

HIGH-VELOCITY IMPACT STUDIES AT THE UNIVERSITY OF UTAH, by W. S. Partridge. [1957] [16]p. incl. illus. diagrs. table, refs. [AF 18(600)1217] Unclassified

Published in Proc. Second Hypervelocity and Impact Effects Symposium, Washington, D. C. (May 22-24, 1957), Washington, Naval Research Lab., v. 1: 93-108, Dec. 1957.

A survey is presented of (1) the interaction of hypervelocity pellets and the atmosphere; and (2) the factors affecting the crater formation in targets which have the

UTA.01:016 - UTA.01:019

same composition as the pellets. The ionization intensity and the time delay in the occurrence of the ionization have been studied as a function of the pellet velocity. The ablation of material from the pellet has been studied as a function of distance. The impact studies include: measurements of the ratio of crater area to pellet area as a function of impact velocity, in the case of wax particles which have velocities above the velocity of sound propagation in the wax; the study of the relationship between crater volume and particle energy; the relationship between crater volume per unit particle energy and a strength parameter of the material; the penetration of the pellet as a function of the velocity; and the variation of the crater volume per unit energy as a function of tin-lead composition.

UTA.01:016

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

SIMILARITIES BETWEEN LUNAR AND HIGH VELOCITY IMPACT CRATERS, by H. B. Van Fleet and W. S. Partridge. [1958] 5p. illus. diagr. (AFOSR-TN-58-27) (AF 18(600)1217) AD 148066 Unclassified

Also published in *Astrophys. Jour.*, v. 128: 416-419, Sept. 1958.

Craters formed by firing small spherical pellets of metal and wax into targets of the same material at velocities up to 5 km/sec exhibit many of the characteristics observed in lunar craters. The following similarities between lunar and high-velocity craters have been noted: (1) the material in the crater lip and in the raised portion of the surface around the crater itself is approximately equal to the volume of material removed in forming the crater; (2) a system of rays resembling lace-work and extending outward from the crater has been observed and postulated to be made up of fragments thrown from the crater at the time of impact; (3) a wrinkled appearance observed around metal targets and attributed to slippage of crystal planes in the solid material resembles very closely the surface surrounding some lunar craters. Other phenomena characteristic of lunar craters and reproducible by high-speed pellets are craters occurring in pairs and others with central peaks. By varying the pellet shape, the target material, and the impact velocity, it is possible to duplicate almost any crater shape observed on the moon.

UTA.01:017

Utah U. Dept. of Electrical Engineering, Salt Lake City.

HIGH VELOCITY IMPACT CRATERS IN LEAD-TIN ALLOYS, by H. B. Van Fleet, C. R. Whited, and W. S. Partridge. Jan. 1958 [46]p. incl. illus. diagrs. tables. (Technical rept. no. 13) (AFOSR-TN-58-28) (AF 18(600)1217) AD 148067 Unclassified

Impact phenomena have been investigated for the lead-tin alloys by firing 3/16 in. spherical pellets from an experimental gun at velocities up to 2.2 km/sec into targets which were large compared to the resultant craters. The pellets and targets were of the same-lead-tin composition in all cases. Quantitative data for the volume, diameter, and depth, along with the mass and velocity of the impinging pellet were obtained for each crater. Correlation has been made between the crater parameters and various functions of the pellet mass and velocity for the following samples: 100% Pb; 90% Pb, 10% Sn; ...; 10% Pb, 90% Sn; 100% Sn. (Contractor's abstract)

UTA.01:018

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

MEASUREMENT OF SONIC VELOCITY IN WAX CYLINDERS, by W. G. Clay and W. S. Partridge. [Dec. 1957] [2]p. incl. diagrs. (AFOSR-TN-58-65) (AF 18(600)1217) AD 148108 Unclassified

Also published in *Jour. Acoust. Soc. Amer.*, v. 30: 151, Feb. 1958.

The velocity of propagation of a low pressure audio wave has been measured as a function of the temperature of wax cylinder sample over a small temperature range near room temperature. A linear relationship between the sound velocity and temperature is observed.

UTA.01:019

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

WAX MODELLING STUDIES OF HIGH-VELOCITY IMPACT IN WAX, by W. S. Partridge and W. G. Clay. [1958] [16]p. incl. illus. diagrs. (AFOSR-TN-58-121) (AF 18(600)1217) AD 152029 Unclassified

Also published in *Jour. Appl. Phys.*, v. 29: 939-942, June 1958. (Title varies)

Penetration of wax pellets into wax targets was found to vary linearly with the cube root of the pellet mass and the pellet velocity up to velocities in excess of twice the sonic velocity in the wax target. The crater area varies directly as the impact velocity, but there is a marked increase in the constant of proportionality above the target sonic velocity. The volume of the crater per unit energy of the pellet was found to be $2.23 \times 10^{-8} \text{ m}^3/\text{joule}$ for the lower velocity range and above the target sonic velocity the value was found to be $2.75 \times 10^{-8} \text{ m}^3/\text{joule}$. It was observed that a large part of the crater volume is created by deformation of the target material and that only a small part is due to ejection of the target material. (Contractor's abstract)

UTA.01:020-023; UTA.03:001

UTA.01:020

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

CRATER FORMATION IN METALLIC TARGETS. PART B. LEAD TIN ALLOYS, by W. S. Partridge, H. B. Van Fleet, and C. R. Whited. [1958] [2]p. incl. diagrs. tables. (AFOSR-TN-58-183) (AF 18(600)1217) AD 152216 Unclassified

Published in Jour. Appl. Phys., v. 29: 1335-1336, Sept. 1958.

The area of the crater as measured in the plane of the original surface of the target was found to be directly proportional to the momentum of the pellet at the time of the impact. In the case of the lead-tin alloy series, a correlation was observed between the crater parameters, the phase diagram of the alloys, and various functions of the pellet mass and velocity for a series of alloys varying from pure lead to pure tin. (Contractor's abstract, modified)

UTA.01:021

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

CRATER FORMATION IN METALLIC TARGETS. PART A. PURE METALS, by W. S. Partridge, H. B. Van Fleet and C. R. Whited. [1958] [3]p. incl. illus. diagrs. table. (AFOSR-TN-58-184) (AF 18(600)1217) AD 152217 Unclassified

Also published in Jour. Appl. Phys., v. 29: 1332-1335, Sept. 1958.

Spheres of copper, lead, tin, iron, aluminum, zinc, silver, and lead-tin alloys were accelerated to velocities of 0.75 to 2.25 km/sec and impacted normally upon targets of the same material as the pellets. Conditions were maintained so that the pellets lost no mass before striking the target. The target mass was large compared to the mass of the pellet, so the targets could be considered semi-infinite. The volume of the crater produced was found to be directly proportional to the kinetic energy of the pellet in the energy range investigated. The penetration varied linearly with the momentum of the pellet. (Contractor's abstract)

UTA.01:022

Utah U. Dept. of Electrical Engineering, Salt Lake City.

FEASIBILITY OF THE ELECTROMAGNETIC ACCELERATOR, by W. S. Partridge, L. D. Harris and others. [1958] 1v. incl. diagrs. tables, refs. (Technical rept. no. 14) (AFOSR-TN-58-517) (AF 18(600)1217) AD 158330 Unclassified

A solenoid-type accelerator was considered in a study

of the feasibility of an electromagnetic device to accelerate small projectiles to velocities of 10 km/sec. The solenoid-type accelerator consists of a hollow coil in which a conducting projectile is placed. A heavy current is passed through the coil, and the resulting magnetic field induces currents in the projectile which react with the magnetic field to accelerate the projectile. Speculation is made on the feasibility of an electromagnetic accelerator that will give a terminal velocity of 10 km/sec to a 5-g projectile. Calculations are appended which predict the length of a multistage accelerator that will produce the desired velocity. The kinetic energy in a 5-g projectile at 10 km/sec is 2.5×10^5 J. With a 10% energy conversion, the energy source must deliver 2.5×10^6 J to the accelerating system. For an accelerator with a 50-m length, the average power requirement from the source is 2.5×10^8 W. The following assumptions were made: (1) the projectile resistance was independent of temperature rise and was that of dc, (2) all energy converted to heat within the projectile is stored, and (3) the slip velocity was constant.

UTA.01:023

Utah U. Dept. of Electrical Engineering, Salt Lake City.

HIGH VELOCITY IMPACT STUDIES. Final interim rept. Dec. 28, 1959 [6]p. incl. refs. (Technical rept. no. 15) (AFOSR-TR-58-107) (AF 18(600)1217) AD 162272 Unclassified

This report presents the problem areas concerning high velocity impact studies. These problem areas are: (1) impact phenomena; (2) acceleration of high-speed particles by electromagnetic means; and (3) acceleration of pellets by means of a light gas gun. An approach to the solution of these problems and future plans are included.

UTA.03:001

Utah U. [Dept. of Metallurgy] Salt Lake City.

BEHAVIOR OF METALS UNDER IMPACT LOADING AND THE MECHANISM OF CRATERING, by X. de Callatay. Oct. 15, 1956 [48]p. incl. illus. diagrs. tables, refs. (Technical rept. no. 2) (AFOSR-TN-57-84) (AF 18(603)100) AD 120432 Unclassified

An initial investigation of the fundamental principles of cratering by multi-particle and single-particle projectiles was carried out to describe actions that occur under one type of loading - that which may develop when an explosive charge is detonated in intimate contact with a body or when one body of high impulse impacts against another. The primary objectives were to investigate jet formation, jet structure, and the initial stages of target penetration by lined cavity charges in regard to impulsive loading. The jet formation and structure studies

UTA.03:002 - UTA.03:005

were carried out to provide some needed information for interpreting ultra-high speed photographs of the penetration of targets by multi-particle projectiles. (Contractor's abstract, modified)

UTA.03:002

Utah U. [Dept. of Metallurgy] Salt Lake City.

MEASUREMENTS OF IONIZATION AND ELECTRON DENSITIES IN THE DETONATION WAVE OF SOLID EXPLOSIVES, by R. T. Keyes and L. D. Lee. Sept. 15, 1956 [37]p. Incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-57-85) (AF 18(603)100) AD 120433
Unclassified

Electrical conduction measurements were made in the detonation wave of loose explosives TNT (coarse and fine), RDX, PETN, tetryl, EDNA, 80/20 AN (ammonium nitrate) - TNT, and in the cast explosives TNT and Composition B. The measured conductivities were found to be of the same order of magnitude as those found in good semi-conductors. The electrical conductivities were used to calculate electron densities within the detonation wave, and these were found to be of the order of 10^{17} $1/\text{cm}^3$ in the ionization region for the explosives tested. Known methods of producing ionization were considered and the conclusion was reached that apparently the only mechanism which can produce ionization of the magnitudes observed is chemical reaction within the detonation wave. In the light of this conclusion, electron-ion recombination times were considered and were concluded to be in the vicinity of 10^{-8} sec, the limitations being imposed by electronic transition probabilities rather than kinetic theory. Since such a recombination time is small compared to explosive reaction times, the results of reaction zone length determinations by means of the current theories were compared with the ionization zone length measurements. Rather good agreement was obtained with one of the published theories of reaction zone length (the "geometrical model"). This result adds credence to the conclusion that chemical reactions are the source of the ionization. Furthermore, since the recombination times were believed to be short and the electron densities high, it appears that there may be approximately one electron liberated for every explosive molecule that reacts in the detonation reaction zone. These free electrons no doubt contribute to various electrical, magnetic and electromagnetic phenomena found recently and presently being studied under this contract. (Contractor's abstract)

UTA.03:003

Utah U. [Dept. of Metallurgy] Salt Lake City.

MECHANISM OF CRATERING IN ULTRA-HIGH VE-

LOCITY IMPACT, by M. A. Cook. July 10, 1957 [28]p. Incl. tables, refs. (AFOSR-TN-57-486) (AF 18(603)100) AD 136479
Unclassified

Also published in Jour. Appl. Phys., v. 30: 725-735, May 1959.

The hydrodynamic theory of penetration of targets by shaped charge jets is summarized and extended to account for crater volumes produced by shaped charge jets. It is then applied in discussing cratering by single-particle projectiles in high velocity and in ultra-high velocity impact, and cratering by multi-particle streams of independently penetrating particles. The conditions for impact explosions of targets and/or projectiles are discussed and theoretical results presented. Finally, impact and explosion cratering are compared.

UTA.03:004

Utah U. [Dept. of Metallurgy] Salt Lake City.

THE GENERATION OF HIGH VELOCITY PROJECTILES WITH HIGH EXPLOSIVES, by R. T. Keyes and M. A. Cook. Oct. 1, 1957, 21p. Incl. diagrs. (AFOSR-TN-57-696) (AF 18(603)100) AD 136698; PB 136441
Unclassified

Also published in Jour. Appl. Phys., v. 29: 1651-1657, Dec. 1958.

A technique of controlling the shape of detonation wave fronts in high explosives by inert wave control inserts was applied to generate discrete ultra-high velocity pellets. Tests to determine the most suitable pellet shape as well as the optimum charge configuration are described, and velocities up to 7600 m/sec were realized for 0.95 g aluminum pellets. The mechanism whereby pellets are accelerated by "shaped" waves is discussed, and the conclusion was reached that a simple model based upon the transmission of shock from the detonation wave to the pellet was not applicable.

UTA.03:005

Utah U. [Dept. of Metallurgy] Salt Lake City.

PROPAGATION CHARACTERISTICS OF DETONATION GENERATED PLASMAS, by L. L. Udy. June 20, 1958 [32]p. Incl. illus. diagrs. table. (AFOSR-TN-58-754) (AF 18(603)100) AD 201613; PB 138177
Unclassified

Also published in Jour. Appl. Phys., v. 30: 1881-1882, Dec. 1959.

Electrical conduction measurements were made in the highly ionized plasma region produced by detonating high explosives. The plasma was determined to originate directly from reaction of the high explosive rather than from thermal ionization associated with the

UTA.03:006; UTA.02:025, 026

accompanying shock wave. The mechanism of conduction was considered, and it was shown that electron flow through the plasma accounted for practically all of the current. With this in mind, it was concluded that the current flow through the plasma region was of the same nature as current flow in a metal. Conduction measurements in atmospheres of Cl_2 , O_2 , N_2 , He, and air showed that the rate of decay of the plasma was dependent upon the gaseous medium and can be explained on the basis of negative ion formation. The plasma exhibited pulsations, and it was concluded that an adhesive attraction exists in the plasma through a quasi-lattice structure. Electron densities of 10^{16} electrons/cc were calculated from conduction measurements of the plasma after it had spread from the 1 in. diameter charge to a 2 in. diameter constraining tube. (Contractor's abstract)

UTA.03:006

Utah U. [Dept. of Metallurgy] Salt Lake City.

IONIZATION IN THE DETONATION REACTION ZONE, by M. A. Cook, R. T. Keyes, and L. D. Lee. [1958] [29]p. incl. diagrs. tables, refs. (AFOSR-TN-58-986) (AF 18-603)100 AD 205912 Unclassified

Electrical conduction measurements were made in the detonation waves of the loose, granular explosives TNT (coarse and fine), RDX, PETN, tetryl, EDNA, 80/20 ammonium nitrate-TNT, and in the cast explosives, TNT and Composition B. The electrical conductivities were used to compute electron densities within the detonation wave, and these were found to be greater than $10^{17}/\text{cm}^3$ in the front of the detonation wave for the explosives considered. Known methods of producing ionization were considered, and it was concluded that only chemionization can produce such high concentrations of electrons. Electron-ion recombination times appeared to be no longer than 10^{-8} sec, the limitation imposed by electronic transition probabilities. Therefore, it was concluded that the conductivity-time curve should be approximately proportional to the chemical reaction rate. On this basis, rather good agreement was obtained with one of the three published theories of the reaction zone length (the geometrical model). Furthermore, it appears that there may be approximately one electron liberated for every explosive molecule formed in the detonation reaction zone, and that a plasma is therefore the transition state (or "activated complex") in the chemical reactions of high explosives. (Contractor's abstract)

UTA.02:025

Utah U. Inst. for the Study of Rate Processes, Salt Lake City.

MECHANISM OF INHIBITOR ACTION FOR CHAIN

PROCESSES, by K. Yang, T. Ree, and H. Eyring. Sept. 30, 1956, 47p. incl. diagrs. tables, refs. (Technical note no. 22) (AFOSR-TN-57-399) (Sponsored jointly by National Science Foundation and Air Force Office of Scientific Research under AF 33(038)20839) AD 122040 Unclassified

Presented at meeting of the Phys. and Inorg. Chem. Div. of the Amer. Chem. Soc., Atlantic City, N. J., Sept. 16-21, 1956.

Abstract published in 130th meeting of the Amer. Chem. Soc. Abstracts of Papers. 1955. p. 24-R.

The classical theories concerning the inhibitor action for chain processes attribute the inhibitory action to the reaction, $\beta(\text{or } \mu) + 1 \rightarrow \text{product}$, where β is the radical which reacts bimolecularly in the chain propagation steps in the Rice-Herzfeld mechanism, μ is the radical acting monomolecularly, 1 is inhibitor, and the term product indicates the substances which are indifferent from the chain reaction system. A mechanism is proposed by which 1 destroys the chain carriers and is regenerated from the bound states, $(\beta 1)$ and $(\mu 1)$. Here, $(\beta 1)$ and $(\mu 1)$ are the complexes which are formed by reactions of 1 with β and μ . Introducing these mechanisms into the Rice-Herzfeld scheme of uninhibited reactions, and applying the steady-state treatment for 12 possible inhibited reaction systems, 2 equations for r/r_0 are obtained in agreement with experiment. Here r and r_0 are the rates of the inhibited and uninhibited reactions, respectively. Results showed that r/r_0 is smaller if the attraction between chain carriers and 1 is larger, the consumption of 1 is smaller, the chain length of the uninhibited reactions is larger, and the reactivities of $(\beta 1)$ and $(\mu 1)$ are smaller. The theory is successfully applied for the inhibited decompositions of normal hydrocarbons and diethyl ether by NO and propylene, for the inhibited pyrolyses of aldehydes, ethers, and ketones by propylene, and for the inhibition of benzaldehyde decomposition by NO. (ASTIA abstract)

UTA.02:026

Utah U. [Inst. for the Study of Rate Processes] Salt Lake City.

A KINETIC THEORY FOR THE OXIDATION OF CARBONIZED FILAMENTS, by G. [D.] Blyholder, J. S. Binford, Jr., and H. Eyring. [1958] [5]p. incl. diagrs. refs. (AF 33(038)20839) Unclassified

Published in Jour. Phys. Chem., v. 62: 263-267, Mar. 1958.

A considerable amount of data on the carbon-oxygen reaction has been collected from the literature, evaluated and expressed in such a manner that comparisons can be

UTA.04:001 - UTA.04:002

made. A theory is proposed which applies to the temperature range from 750 to 2000°. In particular, the unusual maximum in the Arrhenius plot is explained on a theoretical basis.

UTA.04:001

Utah U. [Inst. for the Study of Rate Processes]
Salt Lake City.

KINETICS AND MECHANISM OF DIBORANE PYROLYSIS, by J. R. Morrey and G. R. Hill. Jan. 8, 1958, 137p. incl. illus. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TN-58-220) (AF 49(638)28) AD 154121; PB 134751 Unclassified

A comprehensive literature survey of reactions pertaining to the pyrolysis of boranes has been made in an effort to correlate the pertinent findings so far established. To facilitate further investigation, a heatable infrared cell was constructed. Its description along with the electronic circuit of the temperature controller and pressure measuring devices has been included. Two sets of equations are presented for the analytical determination of mixtures of diborane, tetraborane, pentaborane-9 and pentaborane-11 from infrared spectra for high pressures and for low pressures. A study of the kinetics of pyrolysis of diborane in the infrared cell as well as pyrex cells is herein reported. Evidence is given for second order disappearance at low temperatures and a transition from second order to 3/2 order at about 150°C. First order disappearance data are also discussed. Data are provided to substantiate induction periods in diborane pyrolysis. The catalytic effects of sodium chloride, silicone rubber, teflon, Apieson lubricant and mercury are discussed. Total-pressure-curve characterization has been attempted in order to correlate the various types of curves obtained by different investigators. Unstable, unidentified intermediates in the pyrolysis of diborane have been detected using a "differential method." Preliminary investigations on pentaborane-11 and tetraborane pyrolysis are also presented. In conclusion a mechanism has been postulated which accounts for the activation entropies and enthalpies of the first and three-halves order diborane disappearance. As yet no suitable second-order mechanism has been postulated. (Contractor's abstract)

UTA.04:002

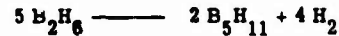
Utah U. Inst. for the Study of Rate Processes,
Salt Lake City.

UNSTABLE INTERMEDIATES IN THE PYROLYSIS OF DIBORANE, by J. R. Morrey, A. E. Johnson and others. [1958] [17]p. incl. illus. diagrs. tables. (AF 49(638)28) Unclassified

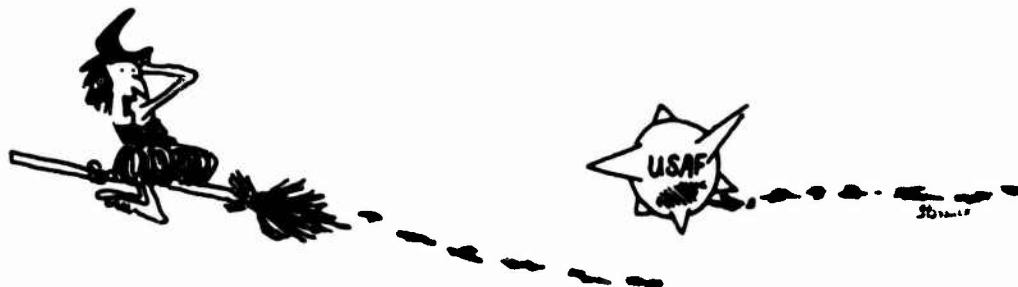
Presented at meeting of the Inorg. Div. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 15, 1958.

Also published in 133rd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 14-L.

Pyrolysis of diborane was carried out in a borosilicate glass cell so designed as to freeze out any products that would condense at dry ice-acetone temperature. Between 100° and 130°C, pentaborane-11 was the main condensable product. The stoichiometry of such a reaction caused a decrease in total pressure, since pentaborane-11 exhibits little vapor pressure:



However, without exception, an initial increase in pressure was observed. Data are presented to show that such a pressure rise was not due to fast initial decomposition of pentaborane-11 to polymer or pentaborane-9. Neither could it be attributed to slow attainment of temperature equilibrium in the cell. An alternative explanation appeared to be a high initial concentration of unstable intermediates in the formation of pentaborane-11. To test this hypothesis, a differential infrared technique was used. Two gas cells filled with diborane were placed in the reference and sample beams of a dual-beam infrared spectrometer and adjusted to compensate each other at room temperature. Rapid heating of the cell in the sample beam produced intermediates which were detected by differential infrared spectra. These intermediates could not be attributed to any of the common volatile hydrides nor to polymer. Assuming the spectrum of the intermediate is due to BH_3 , theoretical calculations have been made of the in-plane bending and stretching and out-of-plane bending force constants, assuming D_{3h} symmetry. On the basis of these constants, the infrared inactive frequency of BH_3 and the normal modes of BD_3 have been predicted. (Contractor's abstract)



VIS.01:004 - VIS.01:007

Virginia Engineering Experiment Station, Blacksburg.
see Virginia Polytechnic Inst. Engineering Experiment
Station, Blacksburg.

VIS.01:004

Virginia Inst. for Scientific Research, Richmond.

MICROTHROWING POWER. A LITERATURE SEARCH,
by E. B. Leffler and H. Leidheiser, Jr. [1957] [9]p.
incl. diagrs. refs. [AF 18(600)1319] Unclassified

Published in Plating, v. 44: 388-396, Apr. 1957.

A summary of the experimental and theoretical work concerned with electrodeposition of metals in isolated surface cavities is presented. This summary will serve as the backdrop against which decisions will be made concerning the experimental approach to Project No. 17 of the American Electroplaters' Society. The report is divided into four sections as follows: (1) A summary is given of the ways in which words such as leveling, throwing power, covering power, etc. have been used; (2) The experimental work on microthrowing power and leveling which is pertinent to the objectives of Project No. 17 is reviewed; (3) A survey is given of the limited theoretical work concerned with deposition within isolated recesses and cavities; and (4) The experimental approach to be used in the initial work is outlined.

VIS.01:005

Virginia Inst. for Scientific Research, Richmond.

THE CORROSION OF SINGLE CRYSTALS AND RE-CRYSTALLIZED SINGLE CRYSTALS OF IRON AND STEEL IN CITRIC ACID, by W. R. Buck, III and H. Leidheiser, Jr. [1957] [8]p. incl. illus. diagrs. table, refs. [AF 18(600)1319] Unclassified

Published in Jour. Electrochem. Soc., v. 104: 474-481, Aug. 1957.

Corrosion studies, largely in 0.2M citric acid at 20°C and the boiling point, were made on polycrystalline disks and monocrystalline spheres and disks of Armco iron and type L steel. Preliminary experiments indicated that the (100) face corroded at the slowest rate and the minor faces, of which the (321) is an example, corroded at the most rapid rate. Quantitative measurements were confined to these two crystal faces. The (100) face was cathodic to the (321) face as shown by potential measurements in 0.2M citric acid in the presence and absence of air. The rate of corrosion of the (321) face was approximately twice that of the (100) face on specimens which were chemically polished, electrolytically polished, machined with a sharp lathe tool, or polished with emery paper. The rates of corrosion of the polycrystalline starting material from which the single crystals were prepared were several times greater

than those of the single crystals. Conversion of the single crystals to polycrystalline material by heating through the transformation temperature resulted in a considerably increased corrosion rate. In the presence of 40-45 ppm of Sn(II) the rates of corrosion of the single crystals in 0.2M citric acid at the boiling point were reduced greatly and no significant difference between the (100) and (321) faces was observed. (Contractor's abstract)

VIS.01:006

Virginia Inst. for Scientific Research, Richmond.

CORROSION OF TEN METALS IN BOILING HYDROCHLORIC ACID WHEN IN CONTACT WITH RHODIUM, PALLADIUM, IRIIDIUM, AND PLATINUM, by W. R. Buck, III, and H. Leidheiser, Jr. [1958] [2]p. [AF 18(600)1319] Unclassified

Published in Nature, v. 181: 1681-1682, June 14, 1958.

The rates of corrosion of aluminum, cadmium, cobalt, iron, lead, manganese, nickel, tin, titanium, and zinc were studied in boiling 2M HCl, with and without contact with platinum, iridium, rhodium and palladium. With the exception of titanium, the rates of corrosion were increased when coupled to the platinum metals. The relative effectiveness of the platinum metals in increasing the corrosion varied with the metal undergoing corrosion. The discrimination between the platinum metals was least for those farther away from platinum in the emf series and greatest for the more noble metals. For eight of the ten metals studied, the average rate of corrosion when coupled to the four platinum metals was related to the standard electrode potential.

VIS.01:007

Virginia Inst. for Scientific Research, Richmond.

THE ACTIVATION AND INHIBITION OF CORROSION OF METALS BY METALLIC CATIONS, by W. R. Buck, III, and H. Leidheiser, Jr. [1958] [5]p. [AF 18(600)1319] Unclassified

Published in Corrosion, v. 14: 22-26, July 1958.

A broad survey was made of the corrosion of Al, Cd, Cu, Au, Fe, Mg, Mn, Mo, Ni, Ag, Sn, Ti, W, Zn, and Zr by fruit and mineral acids at the boiling point in the presence of low concentrations of foreign metallic ions. As a general rule, cations of the elements in Groups II through V in the periodic table showed the highest tendency to decrease the rate of corrosion, and the transition elements in Group VIII showed the highest tendency to increase the rate of corrosion. The relative effectiveness of the ions was a function of the metal undergoing corrosion and the acid used.

VIS.01:008; VPI.02:010, 011; VRU.01:001

VIS.01:008

Virginia Inst. for Scientific Research, Richmond.

ANAEROBIC CORROSION OF METALS IN SOLUTIONS CONTAINING VARIOUS METALLIC CATIONS-INACTIVATION AND ACTIVATION, by W. R. Buck, III, and H. Leidheiser, Jr. [1958] [6]p. incl. diagrs. tables, refs. [AF 18(600)1319] Unclassified

Published in Zeitschr. Elektrochemie, v. 62: 690-695, 1958.

Three cases of the inactivation of a metal by small amounts of a foreign metal originally present as a cation in solution are cited: the inactivation of iron by Sn(II) and Pb(II) ions in boiling 0.2M citric acid; the inactivation of Ni by Cu(II) ions in boiling 2M HCl; and the inactivation of titanium in boiling 2M HCl by the Group VII metals, rhodium, ruthenium, palladium, iridium, osmium, and platinum. Experiments on the activation of aluminum, copper, iron, nickel, silver, tin, and zinc in boiling acids by the Group VIII metals are also described. The foreign metal is considered to exert its influence on the activity of the corroding metal only after it is reduced to the metallic state at the surface. It is suggested that the corrosion rate which results is controlled by the type of electron transfer which occurs between the two kinds of metal atoms at the solution-metal interface. (Contractor's abstract)

VPI.02:010

Virginia Polytechnic Inst. [Engineering Experiment Station] Blacksburg.

FLOW IN THE FORWARD STAGNATION REGION OF BLUNT BODIES, by R. W. Truitt. [1957] [2]p. incl. diagrs. (AF 18(600)641) Unclassified

Published in Jour. Aeronaut. Sciences, v. 24: 380-381, May 1957.

The shock detachment parameter b/a has been calculated for a sphere and cylinder at $M_\infty = 5.8$. It is seen that the calculated value of b agrees with the "average" radius of the experimental shock; similar results were found for the cylinder. It is important to note that a comparison of the theoretical ratio $(b/a)_{\text{sphere}}/(b/a)_{\text{cylinder}}$ for $M_\infty = 5.8$, shows excellent agreement with the experimental ratio measured at the nose. The calculated values of the dimensionless stagnation velocity gradient $\beta D/U$ are plotted versus M_∞ ; the experimental values are given for a hemispherical nose. Although the values of b/a for a cylinder and sphere are different for the same Mach number, the values of $\beta D/U$ are the same in the hypersonic range. Pressure distributions have been calculated for a sphere at $M_\infty = 1.97$ and 3.8 and compared with experimental

values. Although the present analysis is valid only in the stagnation region, the calculated pressure distributions agree with experiment over practically the entire hemisphere.

VPI.02:011

Virginia Polytechnic Inst. [Engineering Experiment Station] Blacksburg.

APPROXIMATE SOLUTION FOR SLIGHTLY YAWED n-POWER BODIES AT HYPERSONIC SPEEDS, by R. W. Truitt. [1958] [2]p. incl. tables. (AF 18(600)641) Unclassified

Published in Jour. Aeronaut. Sciences, v. 25: 206-207, Mar. 1958.

Neglecting centrifugal forces, a reasonable approximation for the pressure distribution over a general slender body at finite hypersonic speeds and small angle of attack may be written as $C_p = 2[1 + \lambda((1+N)/4)](\cos \alpha \sin \theta - \sin \alpha \cos \theta \sin \beta)$. Perhaps the most suitable type body of revolution at hypersonic speeds is the n-power body, of fineness ratio $f = L/d$, with meridian section shape given by $y/(d/2) = (x/L)^n$ where L = length and d = diameter of the body. Cole, taking into account centrifugal forces, derived an expression for the drag coefficient of n-power bodies for the special case of zero angle of attack and $N = 0$. A comparison of Cole's results with those presented in this paper suggests the use of an approximate centrifugal-force correction.

VRU.01:001

Virginia U. Dept. of Mathematics, Charlottesville.

QUASI-OPEN MAPPINGS, by G. T. Whyburn. July 1957, 11p. (Technical note no. 1) (AFOSR-TN-57-395) (AF 49(638)71) AD 132470 Unclassified

Also published in Rev. Math. Pures Appl., v. 2: 47-52, 1957.

A characterization is given of quasi-open mappings from one plane to another in terms of the minimum modulus property which is based on the characterization of such mappings in terms of their action on elementary plane regions. A general mapping result is obtained, and one of its consequences is the result that in a very general setting the quasi-open mappings form a closed class under uniform convergence. The principal theorem states: Let X and Y be locally connected generalized continua and let the sequence of quasi-open mappings $f_n: X \rightarrow Y$ converge almost uniformly to the mapping $f: X \rightarrow Y$. For any $y \in Y$ and any open set V in X containing a nonempty compact component K of $f^{-1}(y)$, there exists

VRU.01:002 - VRU.01:004

a conditionally compact open set U in X with $K \subset \bar{U} \subset V$, a region R in Y about y and an integer N such that for each $n > N$, U contains a component Q_n of $f_n^{-1}(R)$ so that $f_n(Q_n) = R$. The following results are derived from the theorem: (1) the limit mapping f is quasi-open; (2) if each f_n is weakly monotone and $f^{-1}(y)$ has a nonempty compact component for each $y \in Y$, then f is compact and monotone; (3) if f_n is a $\frac{1}{n}$ -mapping for each n and $f^{-1}(y)$ has a nonempty compact component for each $y \in Y$, then f is compact and monotone; and (4) if f is light, the sequence is uniformly approximately open on every compact set A in X . The designation of light means that $f^{-1}(y)$ is totally disconnected for every $y \in Y$.

finer to the case where the domain space X of the mappings is a continuum and where Y is cyclic and the mappings in the sequences are monotone and onto. Corresponding results in less restricted cases are discussed and applied to real functions and to other simplified situations. A statement without proof is given for a result concerned with sequences of quasi-open rather than monotone mappings.

VRU.01:004

Virginia U. Dept. of Mathematics, Charlottesville.

ON CONVERGENCE OF MAPPINGS, by G. T. Whyburn. Oct. 1957, 16p. (Technical note no. 4) (AFOSR-TN-57-709) (AF 49(638)71) AD 136703; PB 133320

Unclassified

Also published in Colloquium Mathematicum (Poland), v. 6: 311-318, 1958.

In this paper the author develops conditions sufficient that sequences of compact mappings and that sequences of quasi-open mappings converge almost uniformly. An example of a sequence of homeomorphisms of the plane onto itself which converges to the identity but for which the convergence fails to be almost uniform is first given. This illustrates that even the strongest conditions on the individual mappings are not sufficient for almost uniform convergence. The first theorem is concerned with a sequence of compact monotone mappings $f_n(X) = Y_n$ and a limit mapping $f(X) = Y'$ where X , Y and Y' are closed generalized continua in a locally compact separable metric space with $Y' \subset Y$ and for each $y \in Y$, Y' intersects each component of $Y - y$. Under the conditions that: (a) the sets Y_n converge 0-regularly to Y (i.e., for any $\epsilon > 0$ there is an N and a $\delta > 0$ such that for all $n > N$ any pair of points $y, y' \in Y_n$, of distance $< \delta$, are in a connected set in Y_n of diameter $< \epsilon$); and (b) for each $x \in X$ and $\epsilon > 0$ there exists an ϵ -neighborhood U of x with boundary C such that $\limsup f_n(C)$ is strictly contained in $f(C)$ (i.e., for every $\epsilon > 0$ almost all of the $f_n(C)$ are in the ϵ -neighborhood of $f(C)$); it is shown that the sequence $\{f_n(x)\}$ converges almost uniformly to $f(x)$ on X and also, if each $f^{-1}(y)$, $y \in Y'$, has a non-empty compact component, that f is compact and monotone. The second theorem is concerned with a sequence of quasi-open mappings $f_n: X \rightarrow Y$, with X and Y locally connected generalized continua such that, for each $y \in Y$, each component of $Y - y$ is non-compact. Under the condition that there exists a mapping $f: X \rightarrow Y$ such that for each $x \in X$ and $\epsilon > 0$ there is a conditionally compact region R , boundary C , $x \in R$ and R in the ϵ -neighborhood of $f^{-1}(f(x))$ with $\limsup f_n(C)$ strictly contained in $f(C)$, it is shown that the sequence $\{f_n(x)\}$ converges almost uniformly to $f(x)$ on X .

VRU.01:002

Virginia U. Dept. of Mathematics, Charlottesville.

TOPOLOGICAL CHARACTERIZATION OF THE SIERPINSKI CURVE, by G. T. Whyburn. Aug. 1957, 8p. (Technical note no. 2) (AFOSR-TN-57-469) (AF 49(638)71) AD 136460

Unclassified

Also published in Fundamenta Mathematicae (Poland), v. 45: 320-324, 1958.

New and simpler proofs for the topological characterization of the Sierpinski curve are given. The proofs are based on markedly different techniques.

VRU.01:003

Virginia U. Dept. of Mathematics, Charlottesville.

UNIFORM CONVERGENCE FOR MONOTONE MAPPINGS, by G. T. Whyburn. Sept. 1957, 12p. (Technical note no. 3) (AFOSR-TN-57-589) (AF 49(638)71) AD 136645

Unclassified

Also published in Proc. Nat'l. Acad. Sciences, v. 43: 992-998, Nov. 1957.

Outlines are presented for some results and methods which lead to existence conclusions for uniform convergence of sequences of mappings in a topological setting of interest; their relation and applicability to sequences of real functions is indicated. A sequence of square mappings of a circle onto itself exists which converges everywhere to the identity mapping but the convergence is not uniform. A general theorem is proved from which it follows that if X and Y are circles and the sequence $h_n(x)$ of homeomorphisms of X onto Y converges everywhere on X to a mapping $f(x)$, then either f is a constant or the convergence is uniform and f is monotone; both cases are realizable. The form of the theorem is con-

VRU.01:005, 006; VRU.02:001-004

VRU.01:005

Virginia U. Dept. of Mathematics, Charlottesville.

ON THE INVARIANCE OF OPENNESS, by G. T. Whyburn. Feb. 1958, 7p. (Technical note no. 5) (AFOSR-TN-58-200) (AF 49(638)71) AD 152233
Unclassified

Also published in Proc. Nat'l. Acad. Sciences, v. 44: 464-466, May 1958.

Further study of spaces in which the open property is a topological invariant for subsets of that space is undertaken. Euclidean spaces and manifolds have this Brouwer property. An invariance theorem concerning the Brouwer property under certain types of mappings is established. This yields not only the existence of spaces other than Euclidean manifolds having this property but also a method of generating such spaces in various ways.

VRU.01:006

Virginia U. Dept. of Mathematics, Charlottesville.

COMPACTNESS OF CERTAIN MAPPINGS, by G. T. Whyburn. May 1958, 14p. (Technical note no. 6) (AFOSR-TN-58-450) (AF 49(638)71) AD 156256
Unclassified

Also published in Amer. Jour. Math., v. 81: 306-314, Apr. 1959.

Theorems are presented which develop conditions that imply compactness of certain mappings with special emphasis on the condition under which certain sets have compact traces.

VRU.02:001

Virginia U. Dept. of Mathematics, Charlottesville.

ON THE HILBERT MATRIX, Π , by M. Rosenblum. July 1957, 6p. refs. (Technical note no. 1) (AFOSR-TN-57-394) (AF 49(638)72) AD 132469 Unclassified

Also published in Proc. Amer. Math. Soc., v. 9: 561-565, Aug. 1958.

A study is presented of the Hilbert matrix, $H_k = ((n+m+1-k)^{-1})$, $m, n = 0, 1, 2, \dots$, where k is a real number that is not a positive integer. When considered as a linear operator on the complex sequential Hilbert space l_2 , H_k is a bounded symmetric operator.

For each real k , a monotone function $\rho_k(\lambda)$ and an isometric map V_k of $L^2(0, \infty)$ onto $L^2(d\rho_k)$ is exhibited

such that $V_k H_k V_k^{-1}$ is a multiplication operator. From this the spectral nature of H_k is determined.

VRU.02:002

Virginia U. Dept. of Mathematics, Charlottesville.

A THEOREM ON QUASI-COMPACT MAPPING, by P. McDougale. Aug. 1957, 6p. (Technical note no. 2) (AFOSR-TN-57-514) (AF 49(638)72) AD 156884
Unclassified

Also published in Proc. Amer. Math. Soc., v. 9: 474-477, June 1958.

The ascertainment of conditions for topological invariances under various types of mappings, especially where the domain space is metric and the mappings are closed or quasi-compact, has received a considerable amount of recent attention. Results indicate that if f is a quasi-compact mapping of a locally compact, separable metric space X onto the topological space Y ; then Y is a locally compact, separable metric space if, and only if, f is a semi-closed, P_2 mapping.

VRU.02:003

Virginia U. Dept. of Mathematics, Charlottesville.

ON A THEOREM OF FUGLEDE AND PUTNAM, by M. Rosenblum. Nov. 1957, 3p. (Technical rept. no. 3) (AFOSR-TN-57-703) (AF 49(638)72) AD 136696
Unclassified

Also published in Jour. London Math. Soc., v. 33: 376-377, July 1958.

A concise proof of Putnam's theorem is given. The case of bounded operators is treated first. An application of Liouville's theorem on the constancy of bounded entire functions is considered. The unbounded case is deduced from the bounded case by employing spectral projections of the operators. The proof presented here is non-spatial, i.e., avoids invoking the Gelfand-Neumark representation theorem.

VRU.02:004

Virginia U. Dept. of Mathematics, Charlottesville.

MAPPING AND SPACE RELATIONS, by P. McDougale. July 1958, 7p. (Technical note no. 4) (AFOSR-TN-58-704) (AF 49(638)72) AD 162236
Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 320-323, Apr. 1959.

Let there be a continuous mapping f from the topological

VRU.02:005 - 008; VRU.03:001

space X to the topological space Y . Given assigned properties as to the nature of X and f , the question of finding the further property of f which is equivalent to a specified property of Y is considered. The investigation is a continuation of previous work by the author and others, and the results include examples of spaces with more elementary properties than have been previously considered.

VRU.02:005

Virginia U. Dept. of Mathematics, Charlottesville.

ON THE EQUIVALENCE OF TWO COHOMOLOGY DIMENSIONS, by E. E. Floyd. July 1958, 11p. (Technical note no. 7) (AFOSR-TN-58-705) (AF 49-638)72 AD 162239; PB 137349 Unclassified

Alexandroff's classical dimension as stated in cohomology form for locally compact Hausdorff spaces X is defined by $\dim_K X \leq n$ if the cohomology groups $H^i(U, K)$ vanish for all $i > n$ and all open $U \subset X$. This Alexander-Spanier cohomology with compact supports is studied so as to show the equivalence with Cartan's cohomology dimension defined in terms of sheaves of coefficients. The $\dim_{\Phi, K} X \leq n$ (Φ is the family of compact subsets of X) if the cohomology groups $H_{\Phi}^i(X, F)$ vanish for all $i > n$ and all K -sheaves F on X .

VRU.02:006

Virginia U. Dept. of Mathematics, Charlottesville.

SEMI-COMPACT MAPPINGS, by P. McDougle. July 1958, 9p. (Technical note no. 5) (AFOSR-TN-58-768) (AF 49(638)72) AD 201923; PB 138175 Unclassified

The semi-compact mapping property is introduced to relate certain important properties in the study of decomposition spaces. Since certain equivalences have been established among space property invariants, mapping properties, and decomposition properties, it seemed feasible to introduce a system of spaces and mappings which characterize many decomposition space problems while obviating the decomposition construction. Particular emphasis is given to the case where point inverses are connected and have bicomact boundaries. (ASTIA abstract)

VRU.02:007

Virginia U. [Dept. of Mathematics] Charlottesville.

STATIONARY POINTS FOR FINITE TRANSFORMATION GROUPS, by J. Greever. Aug. 1958, 15p. (Technical note no. 6) (AFOSR-TN-58-797) (AF 49(638)72) AD 202230; PB 138171 Unclassified

Also published in Duke Math. Jour., v. 27: 163-170, June 1960.

Let (G, X) be a transformation group in which G is finite and X is a finite-dimensional compact Hausdorff space. Various sets of sufficient conditions are given for the existence of at least one fixed point i.e., point fixed under all the transformations of the group. Each set contains (1) the assumption that X is homologically or cohomologically trivial over specified coefficients; (2) the condition that G admits a normal chain of specified type; (3) the hypothesis that the integral cohomology groups of the set F_H of fixed points of the subgroup H

be finitely generated for each H appearing in the normal chain in (2). The quotient groups which appear in (2) are of prime power orders, and at most three distinct primes occur. Suppose, in particular, that the integral cohomology groups of F_H are finitely generated for every subgroup H of G and that those of X are trivial. The theorems above then show that F_G is non-empty when G is abelian and $[G: 1] \leq 210$, also when G is non-abelian and $[G: 1]$ is less than 60 and unequal to 36.

VRU.02:008

Virginia U. Dept. of Mathematics, Charlottesville.

HANKEL MATRICES AND LINEAR FUNCTIONALS ON HARDY SPACES, by M. Rosenblum. Oct. 1958, 17p. incl. refs. (Technical note no. 8) (AFOSR-TN-58-1028) (AF 49(638)72) AD 162295 Unclassified

The proof of the following theorem is discussed: (i) If A is bounded, then $(k_n) \in Y_{r,2}$. (ii) Suppose $(k_n) \in Y_{r,2}$, so $k(\theta) \sim \sum k_n e^{in\theta} \in H_{r,2}$. If $h_1(\theta) \sim \sum x_n e^{in\theta} \in H_{r,4}$ and $h_2(\theta) \sim \sum y_n e^{in\theta} \in H_{r,4}$, then $0.1 \sum_{m+n} x_m y_n = \int_{\pi} (k(-\theta) + j(-\theta)) h_1(\theta) h_2(\theta) d\theta$ for all $j \in J_{r,2}$. A is bounded if and only if there exists a $j \in J_{r,2}$ such that $k + j \in L_{r,\infty}$. (iii) If A is bounded, then $\|A\| = \min \|k + j\|_{r,\infty} : j \in J_{r,2}$.

VRU.03:001

Virginia U. [Dept. of Physics] Charlottesville.

CROSS SECTION FOR THE $Al^{27}(\gamma, 2p) Na^{25}$ REACTION TO 65 MEV, by L. B. Aull and W. D. Whitehead. Jan. 1958 [3]p. incl. diagrs. refs. (AFOSR-TN-58-81) (AF 49(638)176) AD 148129 Unclassified

Also published in Phys. Rev., v. 110: 1113-1115, June 1, 1958.

The $Al^{27}(\gamma, 2p) Na^{25}$ cross section has been determined

AIR FORCE SCIENTIFIC RESEARCH

VIT.01:003 - VIT.01:009

from 25 to 85 mev with respect to the $\text{Cu}^{83}(\gamma, n)\text{Cu}^{62}$ cross section. The cross section has a maximum value of 0.29 mb at 32 mev and the integrated cross section from 25 to 84 mev is 2.8 mev mb. (Contractor's abstract)

VIT.01:003

Vitro Corp. of America, West Orange, N. J.

STUDY OF COMPONENTS OF THE HIGH-INTENSITY ARC TAIL FLAME (Unclassified title), by C. Sheer and A. W. Diniak. Sept. 25, 1957, 21p. incl. illus. diagrs. refs. (Technical note no. 3) (AFOSR-TN-57-684) (AF 18(803)3) AD 136679 Confidential

VIT.01:004

Vitro Corp. of America, West Orange, N. J.

EXPERIMENTAL IDENTIFICATION OF PRODUCTS FROM ARC FLAME REACTIONS (Unclassified title), by A. W. Diniak and C. Sheer. Technical status rept. Nov. 25, 1957, 25p. incl. diagrs. tables. (AFOSR-TN-57-702) (AF 18(803)3) AD 138895 Confidential

VIT.01:005

Vitro Corp. of America, West Orange, N. J.

VAPOR PHASE CARBOTHERMIC REDUCTIONS OF MAGNESIUM OXIDE IN THE HIGH INTENSITY ARC, by S. Korman, A. [W.] Diniak, and C. Sheer. Aug. 22, 1958, 18p. incl. illus. diagrs. tables. (Technical note no. 6) (AFOSR-TN-58-498) (AF 18(803)3) AD 158308; PB 143656 Unclassified

A laboratory investigation of the vapor-phase reduction of magnesium oxide has been carried out in the tail flame of a d-c high intensity arc. Thermodynamic considerations were used to predict an approximate temperature-dependence for the homogeneous reaction, $\text{MgO} + \text{C} \rightarrow \text{Mg} + \text{CO}$, indicating this reaction goes to completion above 1800°C. Since the lowest recorded temperature in the flame was ~ 2000°C, it was assumed that the flame consisted predominantly of reaction products. This was verified by spectrographic observation. The positioning of a water-cooled, copper quench plate for product sampling was fixed by considerations of heat flux and flame temperature as determined spectrographically. For 5/8-in. diameter anodes, containing slightly greater than a stoichiometric fraction of carbon, a 7 kw arc operating in 0.1 atm of nitrogen yielded a product representing 64% reduction of the oxide with an equivalent power consumption of 8.2 kwh/lb of metal. It was concluded that the reaction was a homogeneous one and that the high intensity arc technique offers interesting possibilities in the carbothermic reduction of stable metal oxides. (Contractor's abstract)

VIT.01:006

Vitro Corp. of America, West Orange, N. J.

FURTHER STUDY OF COMPONENTS OF THE HIGH INTENSITY ARC TAIL FLAME (Unclassified title), by C. Sheer and A. W. Diniak. Aug. 7, 1958, 17p. incl. illus. diagrs. tables. (Technical note no. 5) (AFOSR-TN-58-734) (AF 18(803)3) AD 301115 Confidential

VIT.01:007

Vitro Corp. of America, West Orange, N. J.

ROTATIONAL "TEMPERATURE" MEASUREMENTS OF THE HIGH INTENSITY ARC TAIL FLAME, by A. W. Diniak, C. Roth and others. Aug. 7, 1958, 19p. incl. diagrs. table, refs. (Technical note no. 4) (AFOSR-TN-58-735) (AF 18(803)3) AD 201351; PB 143936 Unclassified

Rotational temperatures in the tail flame of the high intensity arc at atmospheric and at reduced pressures are determined by measuring the radiation intensity distribution of the rotational fine structure of the C_2 (0,0) Swan band at λ 5165, and of the OH (0,0) ultra-violet band at λ 3084. A comparison is made between temperatures obtained from the C_2 species, and those obtained from the OH species by both the fundamental and the iso-intensity methods. A discussion of the rotational temperature results obtained is included. (Contractor's abstract)

VIT.01:008

Vitro Corp. of America, West Orange, N. J.

REACTION STUDIES IN THE HIGH TEMPERATURE ARC (Unclassified title), by C. Sheer, A. W. Diniak and others. Summary final rept. Aug. 22, 1958, 56p. incl. illus. diagrs. tables, refs. (AFOSR-TN-58-108) (AF 18(803)3) AD 301351 Confidential

VIT.01:009

Vitro Corp. of America, West Orange, N. J.

THE HIGH INTENSITY ARC AS A PLASMA PROPULSION SOURCE (Abstract), by C. Sheer, L. Mead, and C. D. Fitz. [1958] [1]p. (Bound with its AFOSR-TN-58-125; AD 162274) (Sponsored jointly by Wright Air Development Center under AF 33(616)3669 and Air Force Office of Scientific Research under AF 18(803)3) Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept 30-Oct. 2, 1958.

The use of a plasma jet as the working fluid of a propulsion device provides a system intermediate in properties between the high mass flow — low exhaust velocity, characteristic of the chemical rocket engine, and the low mass flow — high exhaust velocity of the ion propulsion engine. Propulsion by means of a plasma jet is distinguished from ion propulsion in that the latter involves the acceleration of a pair of separated, homogeneous, oppositely-charged particle streams. On the other hand, the plasma medium consists of a partially ionized stream of gas consisting predominantly of neutral particles but containing a sufficient concentration of oppositely charged particles to provide the necessary plasma characteristics. Thus instead of

separate beams of charged particles, there is a single beam characterized by a statistical distribution of electrical dipole moment within the beam. The advantages of a plasma beam over the two ion beams are shown to be (1) that a much higher particle flux can be obtained in a practical generator for the plasma jet and (2) that the energy required to produce the charged particles within the plasma (i.e. establish the electric dipole distribution) is considerably less than that required for the production and separation of pure charged particle beams. As a result of these and other advantages the plasma jet offers promise of superior performance provided an efficient method for plasma acceleration is developed.



WAS.02:026 - WAS.02:030

WAS.02:026

Washington U. Dept. of Mathematics, St. Louis, Mo.

[THE BASIC EQUATIONS OF ELASTICITY AND METHODS OF ATTACK] Ansätze zur Lösung der Grundgleichungen der Elastizitätstheorie, by K. F. Marguerre. [1957] 51p. (AFOSR-TN-57-163) (AF 18(600)568) AD 126455 Unclassified

Also published in Zeitschr. Angew. Math. Mech., v. 35: 242-263, June/July 1955.

The basic equations of elasticity are investigated. Procedures for the elasticity theory of the plane serve as an introduction to the basic problem (that of space, together with the special case of axial symmetry). The speculative "indirect" method having lost some of its significance as function theory permits the "direct" treatment of two dimensional boundary problems.

WAS.02:027

Washington U. Dept. of Mathematics, St. Louis, Mo.

PROJECTIONS ASSOCIATED WITH JACOBI POLYNOMIALS, by I. I. Hirschman, Jr. [1957] 7p. (AFOSR-TN-57-181) (AF 18(600)568) AD 126478 Unclassified

Also published in Proc. Amer. Math. Soc., v. 8: 286-290, Apr. 1957.

A proof is given that $\|\Gamma_\lambda \alpha(n)\|_p < B(p) \|\alpha\|_p$, ($1 < p < \infty$), where $\Gamma_\lambda \alpha(n) =$

$$\sum_{m=0}^{\infty} \alpha(m) \int_{-1}^{\lambda} (n+t)^{\frac{1}{2}} (m+t)^{\frac{1}{2}} P_m(x) P_n(x) dx \text{ and } B(p)$$

depends only upon p and not upon λ . This result is an analog of Pollard's theorem (Trans. Amer. Math. Soc., v. 62: 387-403, 1947; v. 63: 355-387, 1948; and Duke Math. Jour., v. 18: 189-191, 1949).

WAS.02:028

Washington U. Dept. of Mathematics, St. Louis, Mo.

WEIGHTED QUADRATIC NORMS AND ULTRASPHERICAL POLYNOMIALS, I, by R. Askey and I. I. Hirschman, Jr. [1957] 24p. refs. (AFOSR-TN-57-349) (AF 18(600)568) AD 132422 Unclassified

Also published in Trans. Amer. Math. Soc., v. 91: 294-313, May 1959.

The functions $f(x)$ on $[-1, 1]$ which satisfy the condition

$$R_{\beta, \alpha}[f] = \left[\int_{-1}^1 f(x)^2 (1+x)^{\beta} (1-x)^{\alpha} (1-x^2)^{\nu-\frac{1}{2}} dx \right]^{\frac{1}{2}} < \infty \text{ form}$$

a linear metric space $R_{\beta, \alpha}$ with $R_{\beta, \alpha}[f]$ as metric.

The sufficient conditions are sought to ensure the boundedness of a linear transformation T of $R_{\beta, \alpha}$ into itself when T is defined by $(Tf)^{\wedge}(n) = f^{\wedge}(n)t(n)$ and so commutes with the convolution operator in the sense that $(Tf_1)^{\wedge} f_2^{\wedge} = f_1^{\wedge} (Tf_2)^{\wedge}$, where the $f^{\wedge}(n)$ are the coefficients in an expansion of $f(x)$ in terms of the ultraspherical polynomials $W(n, x)$, i.e. $f^{\wedge}(n) =$

$$\int_{-1}^1 f(x) W(n, x) (1-x^2)^{\nu-\frac{1}{2}} dx \text{ for } n = 0, 1, 2, \dots. \text{ The}$$

main conclusion is that T has a bound $C \cdot A(\alpha, \beta, \nu)$

provided that $-\frac{1}{2} < \alpha, \beta < \frac{1}{2}$ and $|t(n)| \leq C, \sum |t(k) - t(k-1)| \leq$

C for sums over $2^n \leq k < 2^{n+1}$. Various relationships between weighted quadratic norms of $f(x)$ and series involving its coefficients $f^{\wedge}(x)$ are given.

WAS.02:029

Washington U. Dept. of Mathematics, St. Louis, Mo.

WEIGHTED QUADRATIC NORMS AND ULTRASPHERICAL POLYNOMIALS, II, by I. I. Hirschman, Jr. [1957] 24p. (AFOSR-TN-57-350) (AF 18(600)568) AD 132423 Unclassified

Also published in Trans. Amer. Math. Soc., v. 91: 314-326, May 1959.

The results of this investigation are the dual of those found in (item no. WAS.02:028). A transformation t of sequences $F(n)$ which commutes with the convolution operator in the sense that $tF_1^{\wedge} F_2^{\wedge} = F_1^{\wedge} tF_2^{\wedge}$ determines a measurable function $t(x)$ on $[-1, 1]$ so that $[tF]^{\wedge}(x) = F^{\wedge}(x)t(x)$. The sequences which $R_{\alpha}[F] =$

$$\left[\sum F(n)^2 \omega(n) (n+1)^{2\alpha} \right]^{\frac{1}{2}} < \infty, \quad (-\frac{1}{2} < \alpha < \frac{1}{2}) \text{ form a linear}$$

metric space R_{α} with $R_{\alpha}[F]$ as metric. A transformation t of R_{α} into itself has a bound $C \cdot A(\alpha, \nu)$ provided that

$$|t(\cos \theta)| \leq C \text{ for } 0 \leq \theta \leq \pi \text{ and } \int |dt(\cos \theta)| \leq C \text{ if the}$$

integral is taken over intervals with end points $\frac{1}{2}\pi(1+2^{-k})$ and $\frac{1}{2}\pi(1+2^{-k+1})$ for all $k = 1, 2, 3, \dots$. Various relationships between weighted quadratic norms of expansion coefficients $F^{\wedge}(x)$ and series of the function $F(n)$ are given.

WAS.02:030

Washington U. Dept. of Mathematics, St. Louis, Mo.

QUADRATIC VARIATIONAL PROBLEMS, by J. Indritz. [1957] 29p. (AFOSR-TN-57-382) (AF 18(600)568) AD 132457 Unclassified

WAS.02:031 - WAS.02:035

An explicit solution obtained previously by the author (Pacific Jour. Math., v. 5, suppl. 1: 765, 1955) for a quadratic variational problem arising from an elliptic partial differential equation with 2 independent variables was extended to the case where there are $S > 2$ independent variables.

WAS.02:031

Washington U. [Dept. of Mathematics] St. Louis, Mo.

ON RINGS OF (γ, δ) -TYPE, by L. A. Kokoris. [1957] 8p. (AFOSR-TN-57-383) (AF 18(600)568) AD 132458
Unclassified

Also published in Proc. Amer. Math. Soc., v. 9: 897-904, Dec. 1958. (Title varies)

Among the algebras of type (γ, δ) [Albert, Portugal Math., v. 8: 23-26, 1949; Kokoris, Canad. Jour. Math., v. 8: 250-255, 1956] those of type $(-1, 0)$ and $(1, 1)$ are residual cases in the classification of almost alternative algebras relative to quasi-equivalence. In this paper the following results concerning rings are proved. (a) Any ring of type $(-1, 0)$ is anti-isomorphic to a ring of type $(1, 1)$. (b) Let A be a simple ring of type $(1, 1)$ whose characteristic is not 2 and which contains an idempotent e ; then either A is associative, or e is the unity element of A . In an appendix is given the extension by Kleinfeld, to rings, of the author's earlier results on algebras of type (γ, δ) . (Math. Rev. abstract)

WAS.02:032

Washington U. Dept. of Mathematics, St. Louis, Mo.

MULTIPLIER TRANSFORMATIONS ON $l^{2,\alpha}$, by A. Devinatz and I. I. Hirschman, Jr. [1958] [21]p. (AFOSR-TN-58-177) (AF 18(600)568) AD 152210; PB 134648
Unclassified

Also published in Ann. Math., v. 69: 575-587, May 1959.

A study is made of the Banach algebra M_α of those bounded linear transformations of $l^{2,\alpha}$ into itself which commute with convolution. The symbolism is as follows: $l^{2,\alpha}$ is the Banach space of those complex functions $F(n)$ for which $\|F\|_{2,\alpha} < \infty$, and $\|F(n)\|_{2,\alpha} =$

$\sum_{n=-\infty}^{\infty} |F(n)|^2 (|n| + 1)^{2\alpha} \}^{1/2}$, $-\frac{1}{2} < \alpha < \frac{1}{2}$, and the operation of convolution, $*$, is defined by $(F*G)(n) =$

$\sum_{k=-\infty}^{\infty} F(n-k)G(k)$. Particular emphasis is given to questions of spectral structure.

WAS.02:033

Washington U. Dept. of Mathematics, St. Louis, Mo.

THE SPECTRA OF MULTIPLIER TRANSFORMS ON l^p , by A. Devinatz and I. I. Hirschman, Jr. [1958] 20p. incl. refs. (AFOSR-TN-58-178) (AF 18(600)568) AD 152211; PB 134647
Unclassified

Also published in Amer. Jour. Math., v. 80: 829-842, Oct. 1958.

Basic, elementary facts about multiplier transforms defined on sequence spaces l^p , $1 < p < \infty$, are summarized, and every such operator T on l^p is shown to correspond to a unique (almost everywhere), bounded, measurable function $T^\wedge(\theta)$ defined on the interval $[0, 1]$. A wide class of functions $T^\wedge(\theta)$ is characterized for which the spectrum of the corresponding multiplier transform T is the essential range of the function. Theorems are given which lead to a characterization of the point spectrum of certain classes of operators in terms of sets of multiplicity for l^p . A method is developed which results in asymptotic formulas for the probabilities

$$P\left(\frac{m-Np}{\sqrt{Npq}} \geq \gamma(N)\right), \text{ where } \gamma(N) = O(N^{-1/2}).$$

WAS.02:034

Washington U. Dept. of Mathematics, St. Louis, Mo.

ON MULTIPLIER TRANSFORMATIONS, by I. I. Hirschman, Jr. [1958] [31]p. (AFOSR-TN-58-179) (AF 18(600)568) AD 152212; PB 134646
Unclassified

Also published in Duke Math. Jour., v. 26: 221-242, June 1959.

Sufficient conditions on a bounded measurable function $T(\theta)$ are investigated which will insure that the multiplier transformations T are bounded on the space of complex functions $L^p(I)$ for $p \geq 2$.

WAS.02:035

Washington U. Dept. of Mathematics, St. Louis, Mo.

A MAXIMAL PROBLEM IN HARMONIC ANALYSIS, II, by I. I. Hirschman, Jr. [1958] 22p. (AFOSR-TN-58-432) (AF 18(600)568; continued by AF 49(638)218) AD 158236
Unclassified

Also published in Pacific Jour. Math., v. 9: 525-540, 1959.

WAS.07:001; WAS.03:006, 007

G a compact topological group with elements x, x_0 , etc. is considered in which a dx is taken which denotes the Haar measure of G normalized by the condition that the measure of G is 1. The matrices $[g(\alpha, i, j, x)]_{i,j=1}^{r(\alpha)}$ $\alpha \in A$ are taken as a complete set of inequivalent unitary representations of G which implies:

$$\int_G g(\alpha, i, j, x) g(\beta, k, l, x) dx = \frac{\delta(\alpha, i, j; \beta, k, l)}{r(\alpha)}.$$

$\delta(\alpha, i, j; \beta, k, l)$ is 1 if $\alpha = \beta$, $i = k$ and $j = l$, otherwise it is zero. Further if $f(x) \in L^2(G)$ and if $c(\alpha, i, j, \eta) = \int_G f(x) g(\alpha, i, j, x) dx$ then

$$\left\{ \sum_{\alpha} r(\alpha) \sum_{i,j=1}^{r(\alpha)} |c(\alpha, i, j, \eta)|^2 \right\}^{1/2} = \|f\|_2.$$

Let $1 < p \leq 2$, $1/p + 1/q = 1$. The inequalities

$$\left\{ \sum_{\alpha} r(\alpha)^2 - q/2 \left[\sum_{i,j=1}^{r(\alpha)} |c(\alpha, i, j, \eta)|^2 \right]^{q/2} \right\}^{1/q} \leq \|f\|_p,$$

$$\text{and } \left\{ \sum_{\alpha} r(\alpha)^2 - p/2 \left[\sum_{i,j=1}^{r(\alpha)} |c(\alpha, i, j, \eta)|^2 \right]^{p/2} \right\}^{1/p} \geq \|f\|_q$$

are shown and determined for $p \neq 2$ for all cases on which equality occurs. (See also item nos. WAS.02:007 and WAS.02:013, Vol. D).

WAS.07:001

Washington U. Dept. of Mathematics, St. Louis, Mo.

ON A LEMMA OF U. V. LINNIK, by A. Devinatz. July 17, 1958, 3p. (AFOSR-TN-58-552) (AF 49(638)-218; continuation of AF 18(600)568) AD 158370

Unclassified

The following theorem is a stronger result of a lemma from the theory of positive functions proposed by U. V. Linnik. If (1) $f(x)$ and $g(x)$ are continuous positive definite functions, (2) and if $g(x)$ is infinitely differentiable, (3) then the Hamburger moment sequence

$$\{(-i)^n g^{(n)}(0)\}_{n=0}^{\infty}$$

is determined, and (4) the origin is a limit point of the zeroes of $f(x) - g(x)$, then $f(x) = g(x)$ on the whole axis.

WAS.03:006

Washington U. [Dept. of Physics] St. Louis, Mo.

ISOTOPIC SPIN AND ANTINUCLEON-NUCLEON SCATTERING, by B. I. Malenka and H. Primakoff. [1957] [6]p. incl. diag. table. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600).77], Office of Naval Research, and Atomic Energy Commission)

Unclassified

Published in Phys. Rev., v. 105: 338-343, Jan. 1, 1957.

The total isotopic spin operator and its square are determined for the quantized nucleon-antinucleon field. In the customary configuration space representation, it is found that in the formula for the total isotopic spin of a system of nucleons and antinucleons, the antinucleons contribute terms with the transposed negatives of the τ operators replacing the corresponding τ 's. The form that has been usually anticipated is found only after a suitable canonical transformation. The results are specifically applied to a 2-particle system consisting of a nucleon and an antinucleon. Expressions are also obtained for the isotopic spin dependence of the ratio of elastic charge exchange to elastic noncharge exchange scattering of an antiproton by a neutron and by a proton. These are discussed and evaluated under certain simplifying assumptions. (Contractor's abstract)

WAS.03:007

Washington U. [Dept. of Physics] St. Louis, Mo.

FURTHER REFINEMENTS ON THE BRILLOUIN-WIGNER PERTURBATION PROCEDURE, by E. Feenberg and P. Goldhammer. [1957] [6]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)777], Office of Naval Research, and Atomic Energy Commission)

Unclassified

Published in Phys. Rev., v. 105: 750-755, Jan. 15, 1957.

The first-order correction to the wave function in the Brillouin-Wigner perturbation procedure is generalized by associating independent amplitude coefficients G_x with each physically distinct type of interaction $W^{(x)}$ occurring in the interaction operator. The modified formulas for wave function and energy can be evaluated by using only quantities which occur in the original formulation of the perturbation procedure (characterized by $G_x = 1$). The

energy formula is invariant under a transformation which changes the scale of all energy denominators by a constant factor. A uniform displacement of the zeroth-order energy spectrum provides an additional variational parameter. A simple example is worked out to show how the computed energy improves as the amplitude parameters are displaced from $G_x = 1$ to optimum values. An incidental result is the observation that the statistical weight of the first order correction to the wave function depends strongly on the amplitude parameters. Finally, results for degenerate and nondegenerate zeroth order states are embodied in an effective interaction operator which determines the energy and the correct zeroth-order linear combination. (Contractor's abstract)

WAS.03:008; WAS.04:020-022

WAS.03:008

Washington U. Dept. of Physics, St. Louis, Mo.

[NUCLEAR REACTION STUDIES], by F. B. Shull.
Final status rept. July 1953-Jan. 31, 1957. Nov. 19,
1957, 11p. incl. tables. (AFOSR-TR-58-74) (AF 18-
(600)777; continued by AF 18(803)108) AD 181652;
PB 135132 Unclassified

Research under the contract concentrated on various
aspects of "stripping" reactions. Proton angular dis-
tributions were measured by a nuclear emulsion tech-
nique. To obtain better results faster a nickel-delay
Hutchinson-Scarrott type multichannel pulse-height
analyzer was constructed with a proportional counter
telescope followed by a scintillation detector. Experi-
mental results are summarized for the following:

Na²³ (d,p)Na²⁴; Ti⁴⁷ (d,p)Ti⁴⁸; Ti⁴⁸ (d,p)Ti⁴⁹;
Fe⁵⁸ (d,p)Fe⁵⁷; Fe⁵⁷ (d,p)Fe⁵⁸; Ni⁶⁰ (d,p)Ni⁶¹;
Ni⁶¹ (d,p)Ni⁶²; Zn⁶⁴ (d,p)Zn⁶⁵; Zn⁶⁶ (d,p)Zn⁶⁷;
Zn⁶⁷ (d,p)Zn⁶⁸; and Zn⁶⁸ (d,p)Zn⁶⁹. Contrary to the
Butler theory, the Zn isotope reactions yielded a rela-
tively high intensity for proton groups whose angular dis-
tributions indicate capture in f or g states, with corre-
spondingly high values of l_n .

WAS.04:020

Washington U. [Dept. of Physics] St. Louis, Mo.

TRANSIENT ELECTRON INDUCTION SIGNALS FROM
SODIUM-AMMONIA SOLUTIONS (Abstract), by V. L.
Poulik and R. E. Norberg. [1956] [1]p. (AF 18(600)-
1133) Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Monterey, Calif., Dec. 27-29, 1956.

Published in Bull. Amer. Phys. Soc., Series II,
v. 1: 397, Dec. 27, 1956.

Observations are reported of electron induction decay
signals from solutions of sodium in liquid NH₃. The
signals appear following the application of fractional
microsecond 30 mc radio-frequency pulses to samples
in a 10.7 oe static magnetic field. The initial tuning
of the oscillator, radio-frequency bridge, and signal
amplifier is accomplished by observation of transient
piezoelectric signals from an NH₄H₂PO₄ powder
sample inserted into one of the high impedance coils
of the bridge. Measurements of electron relaxation
times in the metal-ammonia solutions have been made
with both photographic and electronic integrating tech-
niques. The dependence of the transient induction sig-
nals upon the spacing of the pulses has yielded an elec-
tron T₁ of 2.0 microseconds in a sample of about 0.2

molar concentration. Further measurements corre-
sponding to other concentrations are reported.

WAS.04:021

Washington U. [Dept. of Physics] St. Louis, Mo.

ELECTRON SPIN RESONANCE STUDY OF THE
ELECTRON EXCHANGE BETWEEN NAPHTHALENE
NEGATIVE ION AND NAPHTHALENE, by R. L. Ward
and S. I. Weissman. Dec. 1958 [5]p. incl. diagrs. table,
refs. (Technical rept. no. 15) (AFOSR-TN-57-11)
(AF 18(600)1133) AD 115043 Unclassified

Also published in Jour. Amer. Chem. Soc., 7: 79:
2086-2090, May 3, 1957.

The rate of the electron exchange reaction between
naphthalene negative ion and naphthalene has been de-
termined by a spectroscopic method. Broadening of the
electron spin resonance lines of naphthalene negative
ion occurs in the presence of naphthalene. Bimolecular
rate constants are deduced from the variation of line
breadth with concentration of added naphthalene. The
rate constants vary with the solvent and with the choice
of positive ion. They lie in the range 10^7 - 10^9 liter
mol⁻¹ sec⁻¹.

WAS.04:022

Washington U. [Dept. of Physics] St. Louis, Mo.

SEARCH FOR PARAMAGNETIC RESONANCE AB-
SORPTION IN PHOTOREduced CHLOROPHYLL, by
H. Linschitz and S. I. Weissman. [1957] [2]p. (Techni-
cal rept. no. 16) (AFOSR-TN-57-185) (In cooperation
with Syracuse U., N. Y.) (Sponsored jointly by Air
Force Office of Scientific Research under AF 18(600)-
1133 and Atomic Energy Commission under AT(30-1)820)
AD 126480 Unclassified

Published in Arch. Biochem. and Biophys., v. 67: 491-
492, Apr. 1957.

A search has been carried out for the paramagnetic
resonance absorption due to the free radical semiquinone
which is assumed to be the intermediate in the photo-
sensitized chlorophyll reaction in basic media. No sharp-
line absorption spectra has been found. Thus either the
Krasnovsky intermediate is not a free radical or the ab-
sorption is extremely broad. The first interpretation is
believed to be more likely.

WAS.04:023 - WAS.04:028

WAS.04:023

Washington U. Dept. of Physics, St. Louis, Mo.

SPIN EXCHANGE IN A BIRADICAL, by D. C. Reitz and S. I. Weissman. [1957] [1]p. (Technical rept. no. 17) (AFOSR-TN-57-437) (AF 18(600)1133) AD 136427
Unclassified

Published in Jour. Chem. Phys., v. 27: 968, Oct. 1957.

The rate of spin exchange has been studied by observation of electron spin resonance in the labeled biradical 4-4' oxybistriphenylmethyl. The observed absorption spectrum corresponds to that produced by a model which involves a spin exchange rate which is lower than the hyperfine splitting frequency of 10^8 /sec.

WAS.04:024

Washington U. [Dept. of Physics] St. Louis, Mo.

SPIN DENSITY IN OCTOCYANOMOLYBDATE (V), by S. I. Weissman and M. Cohn. Dec. 1957 [2]p. incl. illus. (Technical rept. no. 22) (AFOSR-TN-57-438) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1133 and National Science Foundation) AD 214106
Unclassified

Also published in Jour. Chem. Phys., v. 27: 1440-1441, Dec. 1957.

The electronic structure of the $\text{Mo}(\text{CN})_6^{3-}$ ion has been investigated by means of the hyperfine structure of its spin resonance system. The origin of the satellites to the Mo line have been shown to be due to the C atoms. From the observed spectra of the molybdate ion, the spin density at each ion has been determined to be 0.96 at the Mo nucleus, 0.088 at each C, and at each N, less than 0.006 units of spin in units of normal hydrogen spin.

WAS.04:025

Washington U. [Dept. of Physics] St. Louis, Mo.

THE SPIN RELAXATION TIME OF TRIPHENYLMETHYL AT LOW TEMPERATURES, by S. I. Weissman, G. Feher, and E. A. Cere. [1957] [2]p. (Technical rept. no. 18) (AFOSR-TN-57-567) (AF 18(600)1133)
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 5584-5585, Oct. 20, 1957.

An argument is presented to reconcile the reported disappearance of the paramagnetism of solid solutions of triphenylmethyl at low temperatures. Due to the long spin-lattice relaxation times measured for triphenylmethyl at low temperatures, the inductance method of

measuring the paramagnetism will yield a value of the susceptibility which is considerably lower than the static value by an amount equal to the square of the ratio of the relaxation frequency to the measuring frequency.

WAS.04:026

Washington U. [Dept. of Physics] St. Louis, Mo.

ELECTRON SPIN RESONANCE AND ELECTRONIC STRUCTURE OF TRIPHENYLMETHYL, by F. C. Adam and S. I. Weissman. Nov. 1957, 13p. incl. diagrs. refs. (AFOSR-TN-57-736) (AF 18(600)1133) AD 214106
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 2057-2059, May 5, 1958.

The anisotropic hyperfine splitting due to C^{13} in the methyl position of triphenylmethyl has been obtained from dilute solutions of triphenylmethyl in triphenylamine. Analysis of the measurements yields an estimate of density of unpaired electron at the methyl position. Estimates of densities at other positions are made from proton hyperfine splittings. The magnitudes of the densities require that some of them have negative sign. A simple valence bond approximation is in good agreement with the observations. (Contractor's abstract)

WAS.04:027

Washington U. [Dept. of Physics] St. Louis, Mo.

ELECTRON SPIN RESONANCE OBSERVATIONS OF PHOTOCROMIC SUBSTANCES, by Y. Hirshberg and S. I. Weissman. [1957] [2]p. (Technical rept. no. 23) (AFOSR-TN-57-795) (AF 18(600)1133) AD 214106
Unclassified

Also published in Jour. Chem. Phys., v. 28: 739-740, Apr. 1958.

Compounds of the bianthone and spiropyran series have been colored by irradiation with ultraviolet light. These colored products have been observed not to exhibit electron spin resonance, even though their concentrations were sufficient to do so.

WAS.04:028

Washington U. [Dept. of Physics] St. Louis, Mo.

FREE RADICAL RESONANCES, by S. I. Weissman. [1957] [2]p. [AF 18(600)1133]
Unclassified

Published in Proc. Conf. on Radio and Microwave Spectroscopy, Duke U., Durham, N. C. (Nov. 4-6, 1957), Washington, Office of Naval Research [1957] p. 53-54.

WAS.04:029 -032; WAS.05:003

A discussion is presented of certain aspects of the magnetic resonance behavior of free radicals. Emphasis is placed on the analysis of hyperfine patterns for stationary electronic states and on secular perturbation of these states.

WAS.04:029

Washington U. [Dept. of Physics] St. Louis, Mo.

DEMONSTRATION OF AN ATOM TRANSFER PROCESS BY ELECTRON SPIN RESONANCE, by F. C. Adam and S. I. Weissman. Feb. 1958 [1]p. (Technical rept. no. 21) (AFOSR-TN-58-132) (AF 18(600)1133) AD 152159

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 1518-1519, Mar. 20, 1958.

The transfer of sodium atoms, rather than separate electrons and sodium ions has been observed in an exchange reaction in a dilute solution of sodium ketyl of benzophenone in 1,2-dimethoxyethane. The electron spin resonance spectrum of this reaction shows a splitting of 1.1 oersteds which is consistent with the interaction of sodium atoms and the solution.

WAS.04:030

Washington U. [Dept. of Physics] St. Louis, Mo.

ELECTRON SPIN RESONANCE SPECTRA OF AROMATIC MONONEGATIVE AND MONOPOSITIVE IONS, by E. de Boer and S. I. Weissman. Mar. 1958 [7]p. incl. diagrs. table, refs. (Technical rept. no. 24) (AFOSR-TN-58-222) (AF 18(600)1133) AD 214106

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 4549-4555, Sept. 5, 1958.

The electron spin resonance spectra of the mononegative ions of anthracene, tetracene, phenanthrene, biphenyl, terphenyl, perylene, pyrene, triphenylene, coronene, fluoranthene, acenaphthylene, acepleiadylene, acenaphthene and acepleiadene are reported. In addition, the electron spin resonance spectra of the positive ions of perylene, tetracene, anthracene, acepleiadylene and acepleiadene have been measured. The spectra are compared with those calculated on the assumption of a linear relationship between hyperfine coupling constant with a proton and the π -spin density on the adjacent carbon. The latter were calculated by a single configuration Hückel molecular orbital treatment. The spectra of the negative ions of all the alternant hydrocarbons except pyrene are in satisfactory agreement with the calculations. The spectra of the negative ions of the non-alternant hydrocarbons fluoranthene and acenaphthylene agree with the calculations while the spectrum of acepleiadylene ion does not. Among the positive ions,

the spectra of the ions of perylene, tetracene and anthracene agree with the calculations; the spectrum of the positive ion of acepleiadene does not. The ions of the partially saturated hydrocarbons acepleiadene and acenaphthene have high coupling constants with the methylene protons and are not satisfactorily treated by simple molecular orbital theory. (Contractor's abstract)

WAS.04:031

Washington U. [Dept. of Physics] St. Louis, Mo.

ELECTRON SPIN RESONANCE SPECTRA OF THE ANIONS OF BENZENE, TOLUENE AND THE XYLENES, by T. R. Tuttle, Jr. and S. I. Weissman. May 1958 [3]p. incl. refs. (Technical rept. no. 25) (AFOSR-TN-58-392) (AF 18(600)1133) AD 214108

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 5342-5344, Oct. 20, 1958.

A description is given of the method of preparation and the measured electron spin resonance spectra of the anions of benzene, toluene, o-xylene, m-xylene, and p-xylene. The distribution of spin density is compared with predictions of molecular orbital theory. (Contractor's abstract)

WAS.04:032

Washington U. [Dept. of Physics] St. Louis, Mo.

THE ELECTRONIC SPECTRA OF AROMATIC HYDROCARBON ANIONS, by E. de Boer and S. I. Weissman. [1957] [3]p. incl. table. [Technical rept. no. 19] (AFOSR-TN-58-612) (AF 18(600)1133; continued by AF 49(638)464) AD 162140

Unclassified

Also published in Recueil Trav. Chim. Pays-Bas, 824-826, Sept./Oct. 1957.

The electronic spectra of several mono- and divalent negative aromatic ions were measured by the use of a Cary spectrophotometer. Comparison is made with the spectra obtained from the same set of ions which were however prepared with the use of sodium as a reducing agent rather than with the use of potassium as in the present case. It is found that the absorption bands are shifted to lower wavelengths by an amount of 0.2 kilokayser in the case in which potassium has been used. In the present case tetrahydrofuran has been used as solvent instead of quaterphenyl.

WAS.05:003

Washington U. Dept. of Physics, St. Louis, Mo.

DRIFT VELOCITIES OF IONS IN NITROGEN AT VARIOUS TEMPERATURES, by F. R. Kovar, E. C. Beaty, and R. N. Varney. [1957] [3]p. incl. diagr. (AFOSR-TN-57-302) (AF 18(600)1317) AD 132373

Unclassified

WAS.05:004, 005; WAS.06:002, 003

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Mar. 1-2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II v. 2: 106, Mar. 1, 1957.

Also published in Phys. Rev., v. 107: 1490-1492, Sept. 15, 1957.

Drift velocities of nitrogen ions in nitrogen gas as a function of field over pressure have been studied by a pulsed Townsend discharge method at temperatures of 77°K, 300°K, and 450°K. Results support the theory that N_2^+ ions are responsible for drift velocities at high E/p_0 values, N_4^+ ions are responsible for drift velocities at low E/p_0 values, while the drift velocity at intermediate E/p_0 values is an average velocity determined by the relative lifetimes in transit of the N_4^+ and N_2^+ ions. Present results further substantiate the existence of N_4^+ at low E/p_0 and N_2^+ at high E/p_0 by showing opposite temperature effects on the mobility of the two ions. The binding energy of the N_4^+ ion has been estimated at 0.14 ev. (Contractor's abstract)

WAS.05:004

Washington U. Dept. of Physics, St. Louis, Mo.

AUGER ELECTRONS IN THE SECONDARY ELECTRON SPECTRUM IN MAGNESIUM, by O. H. Zinke. [1957] [2]p. incl. diagrs. tables. [AF 18(600)1317]

Unclassified

Published in Phys. Rev., v. 106: 1163-1164, June 15, 1957.

By continuously depositing fresh magnesium onto a target surface in high vacuum, it was possible to obtain the spectrum of secondary electrons liberated from atomically clean metal. The results show excellent agreement with predicted Auger transitions, and the continuous background spectrum between Auger peaks vanishes. (Contractor's abstract)

WAS.05:005

Washington U. Dept. of Physics, St. Louis, Mo.

IONS IN NITROGEN, by M. Saporoschenko. [1958] [4]p. incl. illus. diagrs. refs. (AFOSR-TN-58-452) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1317 and Research Corp.) AD 158258

Unclassified

Also published in Phys. Rev., v. 111: 1550-1553, Sept. 15, 1958.

N^+ , N_2^+ , N_3^+ , and N_4^+ ions have been identified in nitrogen gas by use of a mass spectrometer operated with the ion source in the pressure range from 10^{-3} mm Hg to 0.6 mm Hg. Appearance potentials occur at 15.5 ± 0.2 ev for N_2^+ , at 15.8 ± 0.3 ev for N_4^+ , at 22.1 ± 0.5 ev for N_3^+ , and at 24.2 ± 0.4 ev for N^+ ; N_3^+ ions thus are formed only at much higher electron energies than N_2^+ but still at 2 ev less energy than N^+ . It is believed that the N_4^+ is formed by the process $N_2^+ + N_2 \rightarrow N_4^+$ (excited vibrationally) and the N_3^+ is formed by the process $N_2^{++} + N_2 \rightarrow N_3^+ + N$, where N_2^{++} is an excited ion. N_4^+ and N_3^+ currents decrease with increasing E/p in the source, suggesting that they may be dissociated by molecular impacts. The N_4^+ ions are considerably more readily lost than the N_3^+ ions. Since the formation of N_3^+ must necessarily release a nitrogen atom, this process constitutes a form of dissociation of N_2 which may account for the value of the dissociation energy of 7.38 ev found by some methods.

WAS.06:002

Washington U. Dept. of Physics, St. Louis, Mo.

ELUCIDATION OF THE BIOLOGICAL ACTIVITY OF FREE RADICALS BY ELECTRON SPIN RESPONSE, by B. Commoner, J. J. Heise and others. [1957] 28p. incl. diagrs. tables, refs. (AFOSR-TN-57-264) (AF 18- (600)1592) AD 126363

Unclassified

Also published in Science, v. 126: 57-63, July 12, 1957.

Electron spin resonance has been used to investigate the role of free radicals in biochemical processes. Studies of simple enzyme systems, chloroplast systems, and living cells of *Chlorella* have shown the presence of free radicals and have confirmed the prediction of Michaelis that biochemical oxidation-reduction occurs in successive univalent steps which gives rise to free radical intermediates. The chloroplast system studied exhibits both a long and short lifetime persistent radiation after illumination. These emissions can be associated with an electron-transport free radical and an activated chlorophyll complex, respectively.

WAS.06:003

Washington U. [Dept. of Physics] St. Louis, Mo.

ELECTRON SPIN RESONANCE IN BIOLOGICAL SYSTEMS, by B. Commoner. [1957] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1592] and Office of Naval Research)

Unclassified

WAS.06:004, 005; WAS.08:001

Published in Proc. Conf. on Radio and Microwave Spectroscopy, Duke U., Durham, N. C. (Nov. 4-6, 1957), Washington, Office of Naval Research [1957] p. 55-57.

Results are summarized of a series of investigations carried out over the past seven years on the occurrence and activity of free radicals in living cells and in preparations of cell components and enzyme systems. In order to obtain data which might describe the actual physical processes which are involved in metabolic oxidation-reduction, an effort was made to develop experimental systems based on the electron spin resonance technique.

WAS.06:004

Washington U. [Dept. of Physics] St. Louis, Mo.

ELECTRON-SPIN RESONANCE STUDIES OF FREE-RADICAL INTERMEDIATES IN OXIDATION-REDUCTION ENZYME SYSTEMS, by B. Commoner, B. B. Lippincott, and J. V. Passonneau. [1958] [12]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1592] and Office of Naval Research) Unclassified

Published in Proc. Nat'l. Acad. Sciences, v. 44: 1099-1110, Nov. 1958.

The oxidation-reduction processes that occur in living cells and in systems composed of isolated enzymes involve a succession of reactions in which electron transfer is the common characteristic. This conclusion has been inferred from chemical evidence about the structure and reactivity of the system components, but relatively little is known about the physical processes which govern electron transfer among them. This paper is concerned with one of the unresolved problems: the valence of electron transfer. Direct chemical evidence indicates that the net effect of many biochemical oxidation-reduction reactions is the transfer of two electrons. In other cases, notably the cytochrome-cytochrome oxidase system, the same type of evidence indicates that the transfer is univalent. The thermodynamic barriers to the necessary coupling of 2-electron and 1-electron processes are formidable, and this problem has been under active consideration for some time. On the basis of work with model systems, Michaelis proposed a solution which is best summarized in his own statement that "all oxidations of organic molecules, although they are bivalent, proceed in two successive univalent steps, the intermediate state being a free radical." The operative conclusion which emerges from Michaelis' work is that free radicals must occur as intermediates in all biochemical oxidation-reduction processes. The present paper reports detailed experiments on a flavoprotein oxidation-reduction enzyme and less detailed studies of a series of common oxidation-reduction enzyme systems. The

results confirm Michaelis' proposal that free-radical intermediates are characteristic features of enzymatic electron transport. (Contractor's abstract)

WAS.06:005

Washington U. [Dept. of Physics] St. Louis, Mo.

LIGHT-INDUCED FREE RADICALS IN FMN AND FLAVOPROTEIN ENZYMES, by B. Commoner and B. B. Lippincott. [1958] [7]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1592] and Office of Naval Research) Unclassified

Published in Proc. Nat'l. Acad. Sciences, v. 44: 1110-1116, Nov. 1958.

There is some evidence that visible light may influence the rate of cellular respiration and of isolated oxidation-reduction enzyme systems. The evidence is not sufficiently extensive to indicate whether the effect is a general one, nor is it sufficiently detailed to suggest a possible mechanism. The experiments reported provide evidence on these questions. They show that flavin prosthetic groups and flavoprotein oxidation-reduction enzymes readily form free radicals when exposed to ordinary intensities of visible light. The light-induced free radicals appear to be identical with those ordinarily formed as intermediates in the oxidation-reduction process carried out by these components. This effect provides a mechanism which can mediate the influence of light on cellular oxidation-reduction. Since flavoprotein enzymes participate in a wide range of metabolic systems, the evidence also indicates that the observed effect of light on cellular processes is probably of quite general significance.

WAS.08:001

Washington U. [Dept. of Physics] St. Louis, Mo.

CONTINUED FRACTION APPROXIMANTS TO THE BRILLOUIN-WIGNER PERTURBATION SERIES, by R. C. Young, L. C. Biedenharn, and E. Feenberg. Mar. 1957. 18p. incl. diagrs. tables. (AFOSR-TN-57-106) (In cooperation with Rice Inst., Houston, Tex.) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)108; continuation of AF 18(600)777, Office of Naval Research, and Atomic Energy Commission) AD 120457 Unclassified

Also published in Phys. Rev., v. 106: 1151-1155, June 15, 1957.

The Brillouin-Wigner series for the energy is converted into a continued fraction. Refinements on the Brillouin-Wigner formulas developed in recent publications are identified with alternate $(E^{(n)})$ approximants to the continued fraction. A second sequence of approximants

WAS.08:002 - WAS.08:005

$[E^{(n+1)}]$ occurs between successive terms of the $E^{(n)}$ sequence. These are useful in calculations as shown by an illustrative example, but do not possess the extremum property which is a valued characteristic of the first sequence. A general proof is given that the approximants $E^{(n)}$ are invariant under the μ transformation defined and verified for $n = 1, 2$, and ∞ in an earlier publication. (Contractor's abstract)

WAS.08:002

Washington U. Dept. of Physics, St. Louis, Mo.

FREE INDUCTION DECAYS IN SOLIDS, by I. J. Lowe and R. E. Norberg. Mar. 1957, 51p. incl. diagrs. tables. (AFOSR-TN-57-127) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)-108, Office of Naval Research, Atomic Energy Commission, and Alfred P. Sloan Foundation, N. Y.) AD 120483
Unclassified

Also published in Phys. Rev., v. 107: 46-61, July 1, 1957.

A beat structure has been found on free induction decays associated with the pulsed nuclear magnetic resonance of nuclei in rigid lattices. A general quantum mechanical theory is developed for the shapes of induction decays. The theory is specialized to the case of rigid solids and applied to the magnetic dipolar interactions among the F^{19} nuclei in a fluorite (CaF_2) crystal. It is also shown rigorously that, except at very low temperatures, a free induction decay is the Fourier transform of the corresponding steady state resonance line shape. The calculation of the shape of an induction decay in CaF_2 thus corresponds to the calculation of the shape of the F^{19} resonance line for the crystal. It is demonstrated that the resonance line shape for an ordered rigid lattice is not Gaussian. (Contractor's abstract)

WAS.08:003

Washington U. [Dept. of Physics] St. Louis, Mo.

F^{19} NUCLEAR MAGNETIC RESONANCE LINE SHAPES IN CaF_2 , by C. R. Bruce. Mar. 1957, 9p. incl. diagrs. tables. (AFOSR-TN-57-128) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)-108] and Office of Naval Research) AD 120484
Unclassified

Presented at meeting of the Amer. Phys. Soc., Philadelphia, Pa., Mar. 21-23, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 129, Mar. 21, 1957.

Also published in Phys. Rev., v. 107: 43-45, July 1, 1957.

The F^{19} magnetic resonances have been measured in CaF_2 with the magnetic field along the [100], [110], and [111] crystal directions and these data are compared with the data of Pake and Purcell. Calculations of the second and fourth moments for the new data further confirm the theory of Van Vleck on magnetic dipole interactions in solids since improved agreement with theory is obtained in the case of the magnetic field along the [111] crystal direction. Corrections of the moments for modulation broadening were small. (Contractor's abstract)

WAS.08:004

Washington U. Dept. of Physics, St. Louis, Mo.

CONTRIBUTION TO ELASTIC SCATTERING FROM INELASTIC PROCESSES: APPLICATION TO HIGH ENERGY ELECTRON SCATTERING FROM HYDROGEN AND DEUTERIUM, by H. S. Valk. [Apr. 1957] 26p. incl. diagrs. tables, refs. (AFOSR-TN-57-169) (AF 18(603)-108) AD 126462
Unclassified

Also published in Nuovo Cimento, Series X, v. 6: 173-186, July 1, 1957.

An expression is derived in first Born approximation for the correction to high-energy elastic electron-nucleus scattering arising from the existence of non-radiative inelastic processes. The magnitude of this correction is estimated for electron-proton and electron-deuteron scattering and is shown to be a very small but rapidly increasing function of energy over the range of incident electron energies from 150 to 450 mev. The correction to electron-deuteron scattering also shows a marked angular dependence increasing with increasing scattering angle. (Contractor's abstract)

WAS.08:005

Washington U. Dept. of Physics, St. Louis, Mo.

$\pi^+ \rightarrow \pi^0 + e^+ + \nu + 8m_e c^2$?, by E. Feenberg and H. Primakoff. [1957] [6]p. incl. diagrs. table. (Technical rept. no. 5) (AFOSR-TN-57-642) (AF 18(603)108)
Unclassified

Also published in Philosophical Magazine, v. 3: 328-333, Apr. 1958.

The process $\pi^+ \rightarrow \pi^0 + e^+ + \nu$ has not yet been observed. Estimates of its branching ratio relative to $\pi^+ \rightarrow \mu^+ + \nu$ can be derived (1): from a phase space volume argument in conjunction with the available experimental information on π^+ and (assumed analogous) K^+ processes, and (2): from a calculation of the rate of the beta decay transition between the π^+ and π^0 states of a bound

WAS.08:006 - WAS.08:009

nucleon-antinucleon structure. A possible experimental scheme for detection of $\pi^+ - \pi^0 + e^+ + \nu$ in the presence of the overwhelmingly more frequent $\pi^+ - \mu^+ + \nu$ is outlined.

WAS.08:006

Washington U. Dept. of Physics, St. Louis, Mo.

ANALYSIS OF THE SCHRÖDINGER ENERGY SERIES, by E. Feenberg. Mar. 1958 [12]p. incl. refs. (Technical rept. no. 6) (AFOSR-TN-57-687) (AF 18(603)108) AD 136682 Unclassified

Also published in Ann. Phys., v. 3: 292-303, Mar. 1958.

The rate of convergence of the Brillouin-Wigner and Schrödinger energy series can be modified by using elements of freedom present in the formulation of the perturbation problem. Two such elements of freedom are (a) a uniform displacement of the zeroth order energy spectrum and (b) a uniform change of scale in the spacing of the zeroth order energy levels. Transformation a is used to generate the Schrödinger energy series from the corresponding Brillouin-Wigner series. The effect of transformation b on the former series is worked out and exhibited explicitly. The problem of defining a criterion for determining the scale factor is bypassed by the observation that continued fraction approximants to the Schrödinger energy series are invariant under transformation b. Explicit formulas are given for the first three invariant forms. (Contractor's abstract)

WAS.08:007

Washington U. [Dept. of Physics] St. Louis, Mo.

ANGULAR DISTRIBUTION OF D(d,n)He³ NEUTRONS (Abstract), by J. M. Fowler and W. [W.] Daehnick. [1957] [1]p. [AF 18(603)108] Unclassified

Presented at meeting of the Amer. Phys. Soc., St. Louis, Mo., Nov. 29-30, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 350, Nov. 29, 1957.

The angular distribution of neutrons from the reaction D(d,n)He³ has been obtained over the angular range of 0-90° center-of-mass at a deuteron energy of 9.0 mev. The neutrons were detected with a 1 in. x 1 in. x 5 mm plastic scintillator and the photomultiplier pulses were displayed on a multichannel Hutchinson-Scarrott, pulse-height analyzer. The target was deuterium gas at 200 lb per sq in. and the background was measured by comparing "gas in" and "gas out" bombardments. The ex-

perimental angular distributions are compared with the Legendre coefficients found by Brolley, Putnam, and Rosen, and with the predictions of the "exchange stripping" theory.

WAS.08:008

Washington U. [Dept. of Physics] St. Louis, Mo.

ANGULAR DISTRIBUTIONS OF NEUTRONS FROM THE (d,n) REACTION ON B¹¹ (Abstract), by B. Zeidman and J. M. Fowler. [1957] [1]p. [AF 18(603)108] Unclassified

Presented at meeting of the Amer. Phys. Soc., St. Louis, Mo., Nov. 29-30, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 351, Nov. 29, 1957.

The complete angular distributions, from 10° to 160°, of neutrons from the (d,n) reactions on B¹¹ leading to the ground and first excited state of C¹² have been obtained at an incident deuteron energy of 10 mev. The neutrons were detected by a recoil proton telescope consisting of a hydrogenous radiator and two proportional counters operated in coincidence with a scintillation counter. The angular distributions at forward angles have peaks as predicted by the Butler stripping theory with $l_p = 1$. At large angles the distributions for both groups exhibit a nonisotropic structure. Analysis of the distributions in terms of the Owen-Madansky "exchange" stripping theory is discussed. A preliminary analysis indicates that a value of $l_d = 0$, for the angular momentum with which the deuteron is captured and equal probabilities for the forward and backward stripping components gives an adequate fit for the ground-state data.

WAS.08:009

Washington U. [Dept. of Physics] St. Louis, Mo.

DOUBLE PULSE NUCLEAR RESONANCE IN SOLIDS (Abstract), by I. J. Lowe. [1957] [1]p. [AF 18(603)108] Unclassified

Presented at meeting of the Amer. Phys. Soc., St. Louis, Mo., Nov. 29-30, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 344, Nov. 29, 1957.

The general formula describing a free induction decay following one rf pulse has been extended by the insertion of the proper rotation operators to the description of the shape of the free induction signal following two rf pulses separated by time τ . For the case of a rigid

WAS.08:010 - WAS.08:013

solid made up of one magnetically active nuclear species, the formula predicts that a 90° , 180° pulse sequence should produce a free induction signal identical to that for a single 90° pulse and that a 90° , 90° pulse sequence should produce a free induction signal different from that for a single 90° pulse. Experimentally, a "solid echo" is observed to follow the 90° , 90° pulse sequence in all rigid solids examined. For a rigid solid made up of two magnetically active nuclear species A and B, the formula predicts that the free induction signal following a 90°_A , 180°_A pulse sequence should be different from the free induction signal following a 90°_A pulse, and should be identical to the free induction signal following a 90°_A , 180°_B pulse sequence. A "solid echo" has been observed to follow a 90°_F , 180°_F pulse sequence in LiF and NH_4F .

WAS.08:010

Washington U. [Dept. of Physics] St. Louis, Mo.

LONGITUDINAL POLARIZATION OF BETA PARTICLES FROM P^{32} (Abstract), by C. R. Dulgeroff, E. D. Lambe, and T. A. Pond. [1957] [1]p. [AF 18(603)108] Unclassified

Presented at meeting of the Amer. Phys. Soc., St. Louis, Mo., Nov. 29-30, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 348, Nov. 29, 1957.

A horizontal beam of P^{32} electrons is incident on an aluminum foil (typically 0.008 in.) alternately from the east and the west. Electrons multiply scattered downward through 90° are analyzed for transverse polarization by comparison of Mott scattering rates through angles of 75° from vertical in north and south azimuth.

For gold thickness below 0.5 mg/cm^2 (thinnest used: 0.18 mg/cm^2) a constant asymmetry is observed: ratio of north to south scattering rates with source in east, divided by the same ratio with source in the west is 0.840 ± 0.015 . The asymmetry decreases with thicker gold scatterers, indicating the onset of plural scattering. An initial longitudinal polarization of v/c integrated over the measured spectrum analyzed in the Mott scattering leads to a value of the above ratio 0.746 ± 0.050 , the uncertainties lying in the absorption and energy loss corrections to the spectrum. This value includes a correction for the precession of the spins coupled to the multiple scattering process, but does not allow for any further depolarizations.

WAS.08:011

Washington U. Dept. of Physics, St. Louis, Mo.

INTERACTION OF TWO SPHERES, by N. Bernardes. [1958] [14]p. incl. diagrs. (AFOSR-TN-58-191) (AF 18(603)108) AD 152224 Unclassified

The total potential energy of interaction of 2 non-overlapping spherical bodies is calculated in the case of an arbitrary radial distribution of elementary sources within the spheres. The result is expressed as a power series and is applicable to a wide class of interaction potentials depending on the distance between the elementary point-sources. As an illustration, a discussion is given of the interaction of 2 spherical particles composed of point sources interacting according to a Van der Waal's law of force. (Contractor's abstract)

WAS.08:012

Washington U. [Dept. of Physics] St. Louis, Mo.

REMARKS ON SOME IDENTITIES IN STATIC MESON THEORY, by K. Haller. June 1958 [4]p. (Technical rept. no. 9) (AFOSR-TN-58-279) (AF 18(603)108) AD 154181 Unclassified

Also published in Nuovo Cimento, Series X, v. 9: 346-349, July 16, 1958.

An attempt has been made to establish a criterion to be used in deciding when it is permissible to divide an equation by an operator which has 0 as one of its eigenvalues. A new operator has been defined for a class of functions which are essentially bounded and it is found that this function differs from the division function only by including a prescription of the manner in which the contour is to be evaluated. An example is given in the case of a two meson wave function.

WAS.08:013

Washington U. Dept. of Physics, St. Louis, Mo.

DOUBLE BETA DECAY, by H. Primakoff and S. P. Rosen. [1958] [46]p. incl. diagrs. tables, refs. (Technical rept. no. 23) (AFOSR-TN-58-333) (AF 18(603)108) AD 229973

Also published in Repts. on Prog. in Phys., v. 22: 121-166, 1959.

The phenomenon of double beta decay is discussed rather fully both from the experimental and from the theoretical point of view, the relation between double beta decay and the possible kinds of inverse beta decay being also briefly treated. A summary of the available experimental data is given, all methods of detection of the various double beta decay processes being

WAS.08:014 - WAS.08:016

considered. The theory of double beta decay, both in the no-neutrino and in the two-neutrino cases, is worked out, ab initio, on the basis of a nucleon-lepton interaction without conservation of parity. It is particularly emphasized that, with a "two-component neutrino" type nucleon-lepton interaction without conservation of parity, absence of no-neutrino $\beta\beta$ decay does not by itself uniquely imply that neutrino and anti-neutrino are distinguishable and that the total lepton charge is conserved. Comparison of the experimental limits on the double beta decay half-lives with the corresponding theoretical values indicates that two neutrinos are emitted together with two electrons in each double beta decay process—this conclusion is, however, not yet certain and must be confirmed by further experimental work. A treatment is given of the implications of the actual occurrence of two-neutrino rather than no-neutrino double beta decay cations for the problems of neutrino-anti-neutrino identity and conservation of total lepton charge. It is concluded, on the basis of (i) the available double beta decay, inverse beta decay and muon decay experimental data and (ii) the provisional assumption of the universal applicability of "two-component neutrino" type coupling, that a verdict may be tentatively reached in favor of a "Dirac" neutrino, operationally distinguishable from a "Dirac" anti-neutrino, and with conservation of total lepton charge valid in all neutrino interactions. (Contractor's abstract)

WAS.08:014

Washington U. Dept. of Physics, St. Louis, Mo.

THEORY OF SOLID Ne, A, Kr, and Xe at 0°K, by N. Bernardes. Apr. 1958 [6]p. incl. diagrs. tables, refs. (Technical rept. no. 12) (AFOSR-TN-58-342) (AF 18(603)108) AD 154247 Unclassified

Also published in Phys. Rev., v. 112: 1534-1539, Dec. 1, 1958.

A quantum-mechanical variational technique is applied to an Einstein model of a solid, and the heats of sublimation and equations of state of solid Ne, A, Kr, and Xe are calculated at 0°K. Mie-Lennard-Jones 8-12 potentials appropriate to the gas-phase data are used throughout, and the importance of quantum-mechanical effects is discussed; in general, good agreement with experiment is obtained. From the theoretical zero-point energies equivalent Debye temperatures, θ , are calculated, and from the dependence of these θ on volume, Grüneisen constants are computed in good agreement with experiment. Theoretical compressibility curves (at 0°K) are presented, and compared with the available experimental data; in the case of Ne, the only substance for which high-pressure data are available, the agreement is rather good up to 20° K atmosphere. (Contractor's abstract)

WAS.08:015

Washington U. Dept. of Physics, St. Louis, Mo.

THE POLARIZATION OF COSMIC RAY MUONS, by J. M. Fowler, H. Primakoff, and R. D. Sard. June 1958 [19]p. incl. diagr. tables, refs. (Technical rept. no. 10) (AFOSR-TN-58-348) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)108, Office of Naval Research, and Atomic Energy Commission) AD 154253 Unclassified

Also published in Nuovo Cimento, Series X, v. 9: 1027-1045, Sept. 16, 1958.

Also published in Proc. Conf. on Mesons and other Recently Discovered Particles, Padua-Venice (Italy), 1957, p. IV-107.

A partial longitudinal polarization of about 23% is expected for cosmic ray muons due to the falling off of the energy spectrum of the parent pions. A general theory of muon polarization for in flight decays of pions and K mesons has been worked out and applied to cyclotron and cosmic ray experiments. An experiment has been carried out to test the predictions for cosmic ray muons and it has been found that the assumptions made in the theory are correct and that muons suffer negligible depolarization while losing 2 gev energy to the atmosphere.

WAS.08:018

Washington U. [Dept. of Physics] St. Louis, Mo.

PROTON ANGULAR DISTRIBUTIONS FROM $\text{Cr}^{52,53}$ (d,p) REACTIONS, by A. J. Elwyn and F. B. Shull. Aug. 1958 [4]p. incl. diagrs. tables. (Technical rept. no. 7) (AFOSR-TN-58-420) (AF 18(603)108) AD 213989 Unclassified

Also published in Phys. Rev., v. 111: 925-928, Aug. 1, 1958.

Proton angular distributions from (d,p) reactions of 10 mev deuterons on Cr^{52} and Cr^{53} enriched targets were measured and Q values determined for four proton groups from $\text{Cr}^{52}(\text{d,p})\text{Cr}^{53}$ and for six groups from $\text{Cr}^{53}(\text{d,p})\text{Cr}^{54}$. All angular distributions were of type $\epsilon_n = 1$ except for $Q = 4.77$ mev in Cr^{52} reaction, for which $\epsilon_n = 3$. The latter group is interpreted as possibly a single-particle $f_{5/2}$ state, and these data may therefore reveal the relative position of single-particle $f_{5/2}$ and $p_{3/2}$ levels.

WAS.08:017 - WAS.08:020

WAS.08:017

Washington U. [Dept. of Physics] St. Louis, Mo.

INVESTIGATION OF $D(d,n)He^3$ NEUTRONS AT 8.4 MEV, by W. W. Daehnick and J. M. Fowler. Sept. 1958 [5]p. incl. diagrs. table, refs. (Technical rept. no. 8) (AFOSR-TN-58-496) (AF 18(603)108) AD 312989 Unclassified

Also published in Phys. Rev., v. 111: 1309-1313, Sept. 1, 1958.

The angular distribution of neutrons from the reaction $D(d,n)He^3$ has been obtained at 8.4 ± 0.1 mev incident deuteron energy for center-of-mass angles 2° to 84° . A single plastic crystal was used as a detector and deuterium gas at 200 psi as a target. The distribution is fitted by a sum of Legendre polynomials. It is also compared with the predictions of nuclear stripping theory, and adequate agreement is found with an angular distribution of the form $h_d^2 - 2/3h_d h_{d'} + h_{d'}^2$, where the h_d and $h_{d'}$ represent the simple Butler stripping distributions for the incident and target deuterons, respectively. The interaction radius $R_0 = 7 \times 10^{-13}$ cm, has been used. (Contractor's abstract)

WAS.08:018

Washington U. [Dept. of Physics] St. Louis, Mo.

ANGULAR DISTRIBUTIONS FROM DEUTERON BOMBARDMENT OF BERYLLIUM AND BORON, by B. Zeidman and J. M. Fowler. May 1958 [7]p. incl. diagrs. (Technical rept. no. 13) (AFOSR-TN-58-531) (AF 18(603)108) AD 158346 Unclassified

Also published in Phys. Rev., v. 112: 2020-2026, Dec. 15, 1958.

The angular distributions, from 10° to 160° , of the emergent particles from the reactions $Be^9(d,p)Be^{10,10}$, $B^{10}(d,p)B^{11,11}$, and $B^{11}(d,n)C^{12,12}$ have been investigated. The proton distributions were obtained at incident deuteron energies of 10, 9.2, and 8.1 mev while the neutron distributions were obtained with 10-mev deuterons. The proton distributions are analyzed using the Butler theory of deuteron stripping and, with the exception of the distributions from B^{11} , are in agreement with $l_n = 1$ at forward angles. The distributions from the first excited state of B^{11} are not in agreement with any curves based upon the Butler theory, indicating that stripping does not play a major part in this reaction. The neutron distributions are analyzed using the treatment of Owen and Madansky, which allows heavy-particle stripping as well as Butler stripping. Reasonable agreement between the data and this theory for

the ground state is obtained by using approximately equal amplitudes for Butler and exchange stripping and angular momenta of $l=1$ and $l=0$, respectively, for deuteron and exchange stripping. The analysis of the distribution for the first excited state of C^{12} shows $l=1$ for deuteron stripping, but does not provide a unique choice for the angular momentum in exchange stripping.

WAS.08:019

Washington U. [Dept. of Physics] St. Louis, Mo.

PROTON ANGULAR DISTRIBUTIONS FROM $Zn^{64,66,67,68}(d,p)$ REACTIONS, by F. B. Shull and A. J. Elwyn. July 1958 [6]p. incl. diagrs. table, refs. (Technical rept. no. 11) (AFOSR-TN-58-666) (AF 18(603)108) AD 162197 Unclassified

Also published in Phys. Rev., v. 112: 1667-1672, Dec. 1, 1958.

A summary is given of the experimental Q values and proton angular distributions from (d,p) reactions of 10 mev deuterons on a series of isotopically enriched Zn targets. The angular distributions were fitted by Butler curves for which fair agreement was obtained. Well resolved empirical distributions have been obtained for neutron orbital angular momentum quantum number from 0 to 4. Other distributions which are evidently superpositions of groups with various values of angular momentum were not resolvable. (See also item no. WAS.08:016)

WAS.08:020

Washington U. Dept. of Physics, St. Louis, Mo.

THE SCATTERING CONSTANT FOR MULTIPLY-CHARGED PARTICLES IN PHOTOGRAPHIC EMULSION, by C. Fichtel and M. W. Friedlander. Aug. 1958 [7]p. incl. diagrs. table, refs. (Technical rept. no. 24) (AFOSR-TN-58-758) (AF 18(603)108) AD 229973 Unclassified

Also published in Nuovo Cimento, Series X, v. 10: 1032-1038, Dec. 16, 1958.

Numerical values have been calculated for the scattering constant for multiply charged particles in photographic emulsion. The constant has been calculated both with and without a single scattering cut-off correction. The results are presented in graphical form and show a difference in the two calculated values of 4 to 7%. This range of difference as calculated agrees with preliminary tests on the experimental data.

WAS.08:021 - WAS.08:024

WAS.08:021

Washington U. [Dept. of Physics] St. Louis, Mo.

SIMPLIFIED TREATMENT FOR STRONG SHORT-RANGE REPULSIONS IN N-PARTICLE SYSTEMS. I. GENERAL THEORY, by J. W. Clark and E. Feenberg. [1958] [12]p. incl. refs. (Technical rept. no. 19) (AFOSR-TN-58-804) (AF 18(603)108) AD 229980
Unclassified

Also published in Phys. Rev., v. 113: 388-399, Jan. 15, 1959.

A new variational approach is developed for studying the properties of systems of particles interacting through singular short-range repulsions that give rise to strong two-particle correlations. The correlated trial function $\psi = e^{S\phi}$ results, with proper choice of S , in a simple form for the energy expectation value $\langle H \rangle$ - as well as for other matrix elements of interest - which is devoid of all reference to the strong repulsions except through e^{2S} factors and hence is particularly suited to calculation. In many cases an independent-particle type ϕ seems appropriate. The cluster evaluation of this form for $\langle H \rangle$ is discussed, both in the few-particle and many-particle cases. Using the techniques of Iwamoto and Yamada, simplified convergent cluster expansions for the energy expectation value are derived for many-fermion and many-boson systems. A program for application of this method to nuclear problems is being initiated. (Contractor's abstract)

WAS.08:022

Washington U. [Dept. of Physics] St. Louis, Mo.

EFFECT OF THE HYPERFINE SPLITTING OF A μ -MESONIC ATOM ON ITS LIFETIME, by J. Bernstein, T. D. Lee and others. July 1958, 6p. (Technical rept. no. 25) (AFOSR-TN-58-829) (AF 18(603)108) AD 229973
Unclassified

Also published in Phys. Rev., v. 111: 313-315, July 1, 1958.

A calculation is performed and an estimate is given of the small difference in the lifetime of the two hyperfine states of a μ -mesonic atom. A model in which a single unpaired proton exists outside a nuclear core is used to find the spin dependence between the μ -meson and this capturing proton. It is estimated that in the neighborhood of $Z = 10$, a 10% difference in lifetimes is to be expected. Possible experimental detection of this difference is discussed.

WAS.08:023

Washington U. Dept. of Physics, St. Louis.

MOLECULE FORMATION IN THE INERT GASES, by N. Bernardes and H. Primakoff. Oct. 3, 1958 [20]p. incl. diagrs. tables. (AFOSR-TN-58-865) (AF 18(603)108) AD 229980
Unclassified

Also published in Jour. Chem. Phys., v. 30: 691-694, Mar. 1959.

The Schrödinger energy eigenvalue equation for the relative motion of two inert gas atoms is solved approximately by fitting a Morse interatomic potential to the generally accepted Lennard-Jones 12-6 interatomic potential. A condition for binding is derived involving the phenomenological parameters present in the 12-6 potential; from the empirical values of these parameters one can then conclude that all the inert gases, except helium, do form stable diatomic molecules. A qualitative argument is presented showing that an hexatomic helium molecule may be stable. The vibration-rotation energy spectrum of the stable inert gas diatomic molecule is discussed. Finally, the partition function for the diatomic molecule is evaluated in an approximate way, whence, using the standard form for the equilibrium constant in terms of partition functions, it follows that at reasonable values of temperature and pressure several percent of the atoms are associated in the form of diatomic molecules. (Contractor's abstract)

WAS.08:024

Washington U. [Dept. of Physics] St. Louis, Mo.

POTENTIAL ENERGY MATRIX ELEMENTS BETWEEN NON-OVERLAPPING WAVE FUNCTIONS, by N. Bernardes. [1958] [7]p. incl. diagrs. table. (Technical rept. no. 17) (AFOSR-TN-58-866) (AF 18(603)108) AD 229980
Unclassified

Also published in Nuovo Cimento, Series X, v. 11: 628-634, Mar. 1, 1959.

The potential energy matrix elements have been calculated for the interaction of two generalized spherically symmetric, localized and non-overlapping wave functions. The potential has been assumed expressible as a power series and the result is applicable to a wide class of central force potentials and non-overlapping wave functions. An illustration is given of the diagonal matrix elements of the potential energy corresponding to a system satisfying a Van der Waals potential.

WAS.08:025; WAS.09:001-003

WAS.08:025

Washington U. [Dept. of Physics] St. Louis, Mo.

ENERGY OF AN N-PARTICLE SYSTEM WITH STRONG SHORT-RANGE REPULSIONS (Abstract), by J. [W.] Clark and E. Feenberg. [1958] [1]p. [AF 18(603)108] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago U., Ill., Nov. 28-29, 1958.

Published in Bul. Amer. Phys. Soc., Series II, v. 3: 368, Nov. 28, 1958.

A simple variational method is described for calculating the energy of an N-particle system with strong short range repulsive interactions. First the Hamiltonian is written $H = -(\hbar^2/2M)\sum_k \nabla_k^2 + V_A + V_R$, where V_R contains all state independent singular repulsions. Then substitution of e^{Φ} for the wave function Ψ produces the following expression for the expectation value of H:

$$\langle H \rangle = \int e^{2S} \left\{ \frac{\hbar^2}{2M} \sum_k \nabla_k \Phi^* \cdot \nabla_k \Phi + \Phi^* V_A \Phi \right\} \int e^{2S} \Phi^* \Phi$$

provided S satisfied $(\hbar^2/2M)\sum_k [\nabla_k S]^2 + (\Delta_k S) = V_R$ and $[V_A, S] = 0$. The singular two-particle repulsions characteristic of nuclear and other systems may be removed in this fashion, by assuming S to have the form $S = \sum_{i < j} S_{ij}(\gamma_{ij})$. Three-particle interactions implied by this form for S are small in nuclear applications. For some problems an independent particle Φ should be satisfactory, while for others a calculation to higher order in V_A , based on an orthonormal set of such Φ 's, may be required. In this latter case, the matrix elements involved are identical with those of ordinary perturbation theory except for the presence of the correlation factor e^{2S} before each volume element.

WAS.09:001

Washington U. [Dept. of Physics] St. Louis, Mo.

INTRAMOLECULAR ELECTRON EXCHANGE IN ANIONS OF PARACYCLOPHANES, by S. I. Weissman. [1958] [2]p. incl. refs. (Technical rept. no. 28) (AFOSR-TN-58-945) (AF 49(638)464; continuation of AF 18(600)1133) AD 211943 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 6462-6463, Dec. 5, 1958.

Inter-ring electron exchanges have been studied in the paracyclophanes by means of paramagnetic resonance spectra. The unpaired electron is found almost exclusively at the unsubstituted ring positions as previously found in the cases of toluene and p-xylene. In

the [4.4] and [6.6] paracyclophanes the electron exchange proceeds at a frequency which is less than the line breadth of the hyperfine line which is 3×10^6 /sec, while in the [1.8] and [2.2] paracyclophanes it proceeds more rapidly than 1.5×10^7 /sec. In [3.4] the exchange rate is between the above values.

WAS.09:002

Washington U. [Dept. of Physics] St. Louis, Mo.

ON DETECTION OF TRIPLET MOLECULES IN SOLUTION BY ELECTRON SPIN RESONANCE, by S. I. Weissman. [1958] [2]p. incl. table. (Technical rept. no. 27) (AFOSR-TN-58-946) (AF 49(638)464) AD 243091 Unclassified

Also published in Jour. Chem. Phys., v. 29: 1189-1190, Nov. 1958.

In order to observe paramagnetic resonance in excited triplet states in low viscosity fluids, high tumbling rates for the molecules are necessary in order to narrow the dipole coupling of the unpaired electrons. Spin-lattice relaxation times have been calculated as a function of separation of the unpaired electrons for two values of the tumbling rate. It is concluded that appropriate relaxation times are achieved if the separation of the electrons is larger than 6×10^{-8} cm or if the distribution of the electrons is highly symmetrical about one another.

WAS.09:003

Washington U. Dept. of Physics, St. Louis, Mo.

[DOUBLE RESONANCE EXPERIMENTS ON THE FREE RADICAL $(SO_3)_2NO^{\cdot\cdot}$] Expériences de double résonance sur le radical libre $(SO_3)_2NO^{\cdot\cdot}$, by J. H. Burgess. [1958] [5]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49-(638)464] and Office of Naval Research) Unclassified

Published in Jour. Phys. et Radium (Paris), v. 19: 845-849, Nov. 1958.

Double resonance experiments have been carried out on dilute aqueous solutions of the paramagnetic ion $(SO_3)_2NO^{\cdot\cdot}$ in magnetic fields around 30 oersteds. This free radical exhibits a well resolved hyperfine structure with a zero field splitting of 54.7 mc. Radiation of saturating intensity was applied near the resonance frequency of one hyperfine component. At the same time the energy absorption near a second resonance frequency was observed by means of a Pound-Knight type detector operating at a low field intensity level. Resonances were displayed as a function of magnetic field for various applied rf frequencies and for several

WAU.01:018 - WAU.01:021

intensities of the saturating radiation. In cases where there was an energy level common to the two transitions excited by the applied radiations, a splitting of the resonance line occurred. The positions and intensities of the two maxima depended in a detailed manner on the applied frequencies, the strength of the saturating field, the relaxation times of the disulfonate ion and on the behavior of the energy levels with dc magnetic field intensity. In cases where there is no common energy level, no effects of the saturating radiation were observed. An analysis, based on the density matrix equation $d\rho/dt = 1/i\hbar [H, \rho] = 1/T(\rho - \rho_0)$, where ρ_0 is the normalized Boltzmann factor appropriate to the energy of the system in the static magnetic fields, leads to a result for the susceptibility which agrees closely with the observations. (Contractor's abstract)

WAU.01:018

Washington U. Dept. of Chemistry, Seattle.

ELECTRONIC SPECTRA OF PYRIDOCYANINE DYES WITH ASSIGNMENTS OF TRANSITIONS, by G. S. Levinson, W. T. Simpson, and W. Curtis. Apr. 3, 1957, 19p. incl. diagrs. tables, refs. (AFOSR-TN-57-197) (AF 18(600)375) AD 126492; AD 259219 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 4314-4320, Aug. 20, 1957.

The electronic spectra of 2,2'- and 4,4'-pyridocyanine dyes have been investigated. There are absorptions at ~ 490 , 360 and 260 m μ for both the 2,2'- and 4,4'-, which are assigned, respectively, as long axis, short axis and (probably) long axis polarized. The dye 1,1'-diethyl-2,2'-pyridocyanine iodide has been found to exist as the unsymmetrical isomer, and at low temperatures to aggregate into an ion pair and a dimer of ion pairs. The dimer has a triplet-singlet emission with peaks at 600 and 650 m μ . (Contractor's abstract)

WAU.01:019

Washington U. Dept. of Chemistry, Seattle.

POLARIZED ELECTRONIC ABSORPTION SPECTRUM OF AMIDES WITH ASSIGNMENTS OF TRANSITIONS, by D. L. Peterson and W. T. Simpson. [1957] [8]p. incl. diagrs. refs. (AF 18(600)375) AD 259217 Unclassified

Published in Jour. Amer. Chem. Soc., v. 79: 2375-2382, May 20, 1957.

The polarized electronic spectrum of myristamide is obtained to 1600A. It is analyzed into n- π ; NV $_1$;

Rydberg (2p, 3s) and NV $_2$ transitions. Emphasis is on obtaining and interpreting the NV $_2$ transition moment direction. (Contractor's abstract)

WAU.01:020

Washington U. [Dept. of Chemistry] Seattle.

APPLICATIONS OF CONSOLIDATED VARIATION-PERTURBATION THEORY (Abstract), by H. Shull and W. T. Simpson [1957] [1]p. [AF 18(600)375] Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 393, Dec. 19, 1957.

Consolidated variation-perturbation theory as outlined in the previous abstract is demonstrated in its application to two-electron systems, largely to the He atom. The expansion set used is the completely discrete set of associated Laguerre functions of single orbital exponent. For this particular set, it is shown that the second-order result, $W^0 + W^1 + W^2$, is the same irrespective of the explicit choice of division of the nuclear attraction operator between the comparison Hamiltonian and the perturbation term. The explicit choice is important, however, since higher orders in the perturbation theory expansion become small only for an optimum choice. In particular, for $\psi^0 = 1s^2$, $Z = 2$, $W^0 = -4.000$, $W^1 = +1.250$, $W^2 = -0.151$; whereas for $Z = 1.6875$, $W^0 = -2.848$, $W^1 = 0.000$, $W^2 = -0.054$. The improvement becomes progressively more marked for the higher order terms. The systematic application of the remainder theorem to the variation method is shown in two examples: first, without approximation in connection with a He 20 x 20 matrix, and secondly in approximation for a much larger (136 x 136) He matrix.

WAU.01:021

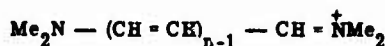
Washington U. Dept. of Chemistry, Seattle.

APPLICATION OF THE PARISER AND PARR METHOD TO DYE IONS WITH AMIDINIUM RESONANCE, by S. P. McGlynn and W. T. Simpson. [1958] [4]p. incl. diagrs. tables. (AF 18(600)375) AD 259220 Unclassified

Also published in Jour. Chem. Phys., v. 28: 297-300, Feb. 1958.

The transition energies and transition probabilities for the family of dye ions

WAU.01:022-024; WAU.02:003, 004



are calculated using the method of Pariser and Parr. The nitrogens are taken into account by a perturbation method. Configuration interaction considering single excitations from the ground configuration is employed, though in the comparison with experiment it is judged better to use the diagonal matrix elements for the transition energies. (Contractor's abstract)

WAU.01:022

Washington U. Dept. of Chemistry, Seattle.

CONSOLIDATED VARIATION PERTURBATION THEORY, by H. Shull and W. T. Simpson. [1958] [4]p. incl. tables. (AF 18(600)375) AD 259221 Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Abstract published in Dull. Amer. Phys. Soc., Series II, v. 2: 392-393, Dec. 19, 1957.

Also published in Jour. Chem. Phys., v. 28: 925-928, May 1958.

A formula is derived which gives the exact remainder to the approximate energy eigenvalue obtained by the variation method. The remainder formula and approximations to it are closely related to the usual second-order perturbation formula. A scheme is suggested for consolidating the linear variation method and remainder formula into a single approximation method for energy eigenvalues. The method is illustrated with a calculation of the energy of the ground state of helium using 136 basis functions. (Contractor's abstract)

WAU.01:023

Washington U. Dept. of Chemistry, Seattle.

FORMAL HÜCKEL THEORY, by W. T. Simpson. [1958] 3p. incl. diagrs. (AF 18(600)375) AD 259222 Unclassified

Also published in Jour. Chem. Phys., v. 28: 972-974, May 1958.

Using the nondiagonal potential energy operator the Hückel theory may be formally stated. The formal theory is consonant with the idea of the Fermi hole. Since it is presented as the zeroth-order part of a perturbation theoretical treatment of the true Hamiltonian the perturbation is explicitly known by difference.

WAU.01:024

Washington U. Dept. of Chemistry, Seattle.

ELECTRONIC SPECTRUM OF 4,4'-bis DIMETHYL-AMINO FUCHSONE AND RELATED TRIPHENYL-METHANE DYES, by F. C. Adam and W. T. Simpson. Sept. 2, 1958 [18]p. incl. diagrs. tables. (AF 18(600)375) AD 259223 Unclassified

Also published in Jour. Molecular Spectroscopy, v. 3: 363-380, Aug. 1959.

The electronic absorption and emission spectra of 4,4'-bis dimethylamino fuchsones (BDF) and of crystal violet (CV) have been studied using a variety of solvents and experimental conditions. Analysis of the relative polarizations of the bands leads to the conclusion that for BDF the two long wavelength transitions have crossed over relative to the ordering found in the malachite green series of dyes. These results are discussed from the point of view of the low-energy structures. The absorption intensities are calculated on this basis and the values obtained are found to be in reasonable agreement with experiment. Evidence is cited for the existence of CV in nonpolar solvents as an ion pair. (Contractor's abstract)

WAU.02:003

Washington U. Dept. of Chemistry, Seattle.

SOLID SOLUTION ARGON-KRYPTON FROM 70 TO 96°K, by J. F. Walling and G. D. Halsey, Jr. Oct. 20, 1958 [5]p. incl. diagrs. tables. (AFOSR-TN-58-43) (AF 18(600)987) AD 148084 Unclassified

Also published in Jour. Phys. Chem., v. 62: 752-753, June 1958.

Static vapor pressure measurements have been made over a solid solution of argon and krypton. The data have been analyzed according to the Fowler and Guggenheim random-mixed approximation to regular solution theory. The energy of mixing parameter w_{AB} has been found to be equal to $320 - 1.7T \pm 50$ and the extrapolated critical temperature for phase separation T is determined to be equal to $56 \pm 8^\circ\text{K}$.

WAU.02:004

Washington U. Dept. of Chemistry, Seattle.

SOLUBILITY OF HELIUM AND NEON IN LIQUID ARGON. AN APPROXIMATION TO THE ENTROPY OF LATTICE VACANCY FORMATION IN LIQUID ARGON, by F. E. Karasz and G. D. Halsey, Jr. Oct. 20, 1958 [24]p. incl. diagrs. tables, refs. (AFOSR-TN-58-59) (AF 18(600)987) AD 148101 Unclassified

WAU.02:005 - WAU.02:008

Also published in Jour. Chem. Phys., v. 29: 173-179, July 1958.

The solubilities of helium and neon in liquid argon have been measured over the temperature range 83.9 to 87.5°K. The observed heat of solution for helium is 1520 cal/mol and for neon is 390 cal/mol. These data have been analyzed by means of a modified Lennard-Jones-Devonshire cell theory of liquids to yield an entropy for lattice vacancy formation of approximately 24 eu.

WAU.02:005

Washington U. Dept. of Chemistry, Seattle.

THE INTERACTION OF KRYPTON WITH METALS. AN APPRAISAL OF SEVERAL INTERACTION THEORIES, by R. A. Pierotti and G. D. Halsey, Jr. [1958] [35]p. incl. diagrs. tables, refs. (AFOSR-TN-58-814) (AF 18-600)987) AD 232045 Unclassified

Also published in Jour. Phys. Chem., v. 63: 680-686, May 1959.

Adsorption data for the interaction of krypton with evaporated films of iron, copper, sodium and tungsten at 75°K have been obtained. Krypton isotherms on sodium films treated with oxygen and water vapor are reported. Interaction energies are determined and compared with those predicted by several dispersion force theories. It is found that the Kirkwood-Muller equation is the most suitable of the theories considered and that it yields semiquantitative agreement with experiment for both metallic and non-metallic adsorbents. It is possible to predict the general form of isotherms of the rare gases on homogeneous surfaces by using Kirkwood-Muller energies in an isotherm equation developed by Singleton and Halsey [Canad. Jour. Chem., v. 33: 184, 1954]. (Contractor's abstract)

WAU.02:006

Washington U. Dept. of Chemistry, Seattle.

INTERACTION OF SINGLE ARGON ATOMS WITH GRAPHITIZED CARBON BLACK P-33(2700), by G. Constabaris and G. D. Halsey, Jr. Oct. 20, 1958, 1p. incl. table. (AFOSR-TN-58-997) (AF 18(600)987) AD 205741 Unclassified

Also published in Jour. Chem. Phys., v. 27: 1433-1434, Dec. 1957.

The interaction of single argon atoms with a highly homogeneous carbon black P-33(2700) has been measured and the data treated by the method of Steele and Halsey to obtain the following results: the absorption energy $\epsilon^* = 2,410$ cal/mol, the distance of closest ap-

proach $D = 3.35$ Å and surface area $A = 16 \text{ m}^2/\text{g}$. The differences between these results and those obtained by W. A. Steele (Jour. Chem. Phys., v. 22: 979, 1954) are attributed to the effect of "hot spots" on the latter type of surface.

WAU.02:007

Washington U. Dept. of Chemistry, Seattle.

A PRECISION ADSORPTION APPARATUS FOR THE STUDY OF THE INTERACTIONS BETWEEN GAS ATOMS AND SURFACES, by G. Constabaris, J. H. Singleton, and G. D. Halsey, Jr. Nov. 1958, 20p. diagrs. tables, refs. (AFOSR-TN-58-1048) (AF 18(600)987) AD 232046 Unclassified

Also published in Jour. Phys. Chem., v. 63: 1350-1355, Sept. 1959.

A precision apparatus for the study of the interactions between gas atoms and surfaces of low specific area is described. A low temperature adiabatic calorimeter is used as the sample cryostat and the precise techniques of gas thermometry are used for pressure measurement. The gas is metered into the system with an accurate gas transfer apparatus. Data for the measurement of known volumes, and of the apparent volume of a vessel containing a low specific area, highly graphitized carbon black, are given. These measurements, made with different rare gases at various temperatures, indicate a precision of between 1 and 2 parts per 10,000. The apparent volume data are converted to the usual quantity of adsorbed volume to give room temperature adsorption isotherms at coverages of less than 2% of the monolayer. (Contractor's abstract)

WAU.02:008

Washington U. Dept. of Chemistry, Seattle.

EXACT LATTICE-CLUSTER EXPANSION FOR THE FROST POINTS OF ARGON-KRYPTON GAS MIXTURES, by J. F. Walling and G. D. Halsey, Jr. [1958] 12p. diagrs. table. (AFOSR-TN-58-1098) (AF 18(600)987) AD 232047 Unclassified

Also published in Jour. Chem. Phys., v. 30: 1514-1517, June 1959.

The frost points of argon-krypton mixtures at various pressures and compositions of the gas phase have been determined. These results have been analyzed by a generalized form of regular solution theory, where the energy of mixing parameter w_{AB} has been allowed to vary with mole fraction as well as temperature. The results have been compared with an exact expansion in terms of Mayer cluster sums of the lattice-solution (Ising) model. The model does not entirely account for the data.

WAU.04:001, 002; WAU.05:001, 002

WAU.04:001

Washington U. Dept. of Chemistry, Seattle.

BOND MOMENTS AND BOND MOMENT DERIVATIVES OF $C^{12}N^{14}_2$ AND $C^{12}C^{13}N^{14}_2$ FROM INFRARED INTENSITIES, by J. W. Schultz and D. F. Eggers, Jr. [1958] 16p. diagrs. tables. (Technical note no. 1) (AFOSR-TN-58-204) (AF 18(600)1522) AD 152237
Unclassified

Presented at Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 1957.

Also published in Jour. Molecular Spectroscopy, v. 2: 113-119, Apr. 1958.

The intensities of the molecular vibration of frequency ν_3 in C_2N_2 as well as ν'_1 and ν'_4 in the isotopically substituted, non-symmetric molecule CC^*N_2 were measured. The later measurement was carried out in a mixture containing 15.5 atomic percent of the species containing C^{13} indicated as C^* . The intensities were interpreted in standard fashion as bond moments and derivatives, after carrying out a normal coordinate calculation. This calculation yields a CN bond moment of 0.8 debye and a bond moment derivative of 0.59 debye/angstrom. This latter value fits both of the stretching vibrations, indicating that the dipole moments of the two bonds add independently with no interaction. (Contractor's abstract, modified)

WAU.04:002

Washington U. Dept. of Chemistry, Seattle.

MICROWAVE SPECTRUM, STRUCTURE, AND DIPOLE MOMENT OF CYCLOPROPENE, by P. H. Kasai, R. J. Myers and others. [1958] 17p. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-58-854) (AF 18(600)1522) AD 203500
Unclassified

Also published in Jour. Chem. Phys., v. 30: 512-516, Feb. 1959.

The microwave spectra of four isotopic species of cyclopropene, $CH_2(CH)_2$, CH_2CDCH , $CH_2(CD)_2$, and $CDE(CH)_2$ were assigned and three rotational constants for each isotopic species were determined. From these data the following structural parameters were evaluated: the bond lengths C-C 1.515 Å, C=C 1.300 Å, C-H (methylene) 1.087 ± 0.004 Å, C-H (vinyl) 1.070 Å, and the intermolecular bond angles H-C-H angle 114°42' ± 10' and C-C-H angle 149°55'. The uncertainties in

the methylene values are the magnitude of a rotation-vibration interaction correction. The dipole moment of cyclopropene was found to be 0.455 ± 0.01 debye unit. (Contractor's abstract)

WAL.05:001

Washington U. Dept. of Chemistry, Seattle.

ALKENYLBORANES. I. PREPARATION AND PROPERTIES OF SOME VINYL- AND PROPENYLBORANES, by T. D. Parsons, M. B. Silverman, and D. M. Ritter. Apr. 15, 1957 [28]p. incl. diagrs. tables, refs. (AFOSR-TN-57-110) (AF 18(600)1541) AD 120463
Unclassified

Presented at meeting of the Amer. Chem. Soc., Atlantic City, N. J., Sept. 16-21, 1956.

Abstract published in 130th meeting of the Phys. and Inorg. Chem. Div. of the Amer. Chem. Soc. Abstracts of Papers, 1956, p. 35-R-36-R. (Title varies)

Also published in Jour. Amer. Chem. Soc., v. 79: 5091-5098, Oct. 5, 1957.

Dimethylvinyl-, methyldivinyl- and trivinylborane, dimethylpropenyl- and methylpropenylborane were prepared from dimethylbromoborane and vinylsodium or propenyllithium, respectively. The products in each case were separated by fractional condensation and the vinyl derivatives were separated more effectively by gas partition chromatometry. The structures were demonstrated to be as claimed through identity of the hydrocarbons formed in the reaction with silver ammonium ion. Acidity of the vinylboranes toward ammonia was diminished as would be expected if the vacant boron orbital participated in the pi-electron system belonging to the alkenyl substituents. Relative acidity was found to account for the several products obtained in the preparative reaction, for absence of reaction of trivinylborane with oxygen and the slow autooxidation of methyldivinylborane.

WAU.05:002

Washington U. Dept. of Chemistry, Seattle.

VINYL-ALKALI METAL COMPOUNDS, by R. G. Anderson, M. B. Silverman, and D. M. Ritter. [1958] [1]p. (AFOSR-TN-58-772) (AF 18(600)1541) AD 222412
Unclassified

Also published in Jour. Org. Chem., v. 23: 750, May 1958.

Solid vinyl-alkali compounds have been prepared by reaction of vinyl chloride with a 90% potassium-sodium alloy in the presence of tetrahydrofuran. An original yield of 32% was obtained.

WAU.03:012, 013; WAU.06:001

WAU.03:012

Washington U. Dept. of Physics, Seattle.

SLOW SPIN RELAXATION OF OPTICALLY POLARIZED SODIUM ATOMS, by H. G. Dehmelt. [1957] [3]p. incl. diagrs. [AF 18(600)653] Unclassified

Published in Phys. Rev., v. 105: 1487-1489, Mar. 1, 1957.

In order to obtain as narrow as possible paramagnetic resonance signals, it is of importance to investigate the conditions under which long relaxation times can be realized. In the present experiment on sodium atoms diffusing in argon gas, relaxation due to sodium-sodium collisions was minimized by employing very low sodium

partial vapor pressures (about 10^{-7} mm Hg). While at lower pressures the argon is serving its function well to slow down relaxation by inhibiting wall diffusion, at about 10 cm Hg relaxation due to sodium-argon collisions becomes the decisive factor. Nevertheless it was possible to realize a relaxation time of 0.21 sec for a 1-liter spherical bulb filled with 3 cm argon. About 0.02 sec was found for a 0.1-liter, 40 cm argon sample. In carrying out the experiments, optical pumping by circularly polarized resonance radiation was used to create an orientation of sodium atoms which then was monitored by measuring the transmission of the pumping radiation through the sample. By suddenly reversing a small axial magnetic field, the polarization of the atoms could be made to reverse too. From the decay rates of this inverted polarization under the combined effects of relaxation and continuing optical pumping, the experimental relaxation times were deduced. The strong signals obtained are indicative of available signal to noise ratios in future radio-frequency resonance reorientation experiments using the transmission monitoring technique. A theoretical analysis of the optical pumping process, including the dynamic aspects and allowing for collisions with argon that the sodium atoms undergo while in the excited state, was carried out and used to describe the experimental data. (Contractor's abstract)

WAU.03:013

Washington U. [Dept. of Physics] Seattle.

THE EXCITATION OF NUCLEAR SPIN TRANSITIONS IN CRYSTALS BY ULTRASONIC OSCILLATIONS, by E. A. Uehling. Final rept. Apr. 1, 1958, 21p. incl. refs. (AFOSR-TR-58-51) (AF 18(600)653; continued by AF 49(638)92) AD 154201 Unclassified

When these experiments were begun a direct connection between the orientations of nuclear spins in crystals and the lattice vibrations had not been established experimentally. The discovery of such a connection constitutes the principal achievement of this work.

Additional objectives which were realized include: (a) the measurement of the vibrational energy which is required in order to disturb the spin orientation by a known amount; (b) a study of the sensitivity of this effect in several distinctly different types of crystals; (c) an attempt to measure an acoustic relaxation parameter known as the phonon relaxation time T_p which has been

little studied in the history of physics but which is important in the interpretation of these experiments; and (d) a development of the theory of the processes which are under observation. In addition some studies of quadrupole interactions without specific reference to the interaction with lattice vibrations were made. The purpose of these studies was to investigate the nature of the electric field gradients responsible for the nuclear interaction with the lattice. (Contractor's abstract)

WAU.06:001

Washington U. [Dept. of Physics] Seattle.

DETECTION OF ATOMS IN THE NITROGEN AFTERGLOW (Abstract), by R. A. Young and R. Sharpless. [1958] [1]p. [AF 18(603)36] Unclassified

Presented at meeting of the Amer. Phys. Soc., British Columbia U., Vancouver (Canada), Aug. 26-28, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 320, Aug. 26, 1958.

Using a high sensitivity ($\sim 10^5$ mm Hg atomic partial pressure), fast response (~ 1 sec), Wrede gauge measurements have been made of the atom concentration as a function of time for 2 min during the decay of the active nitrogen. The nitrogen afterglow, in a two liter glass bulb coated exteriorly with MgO, is simultaneously observed through a 5790 Å interference filter by a photomultiplier (RCA 6655). The light detection and collection system has been calibrated. It was found that: (1) the atoms exhibit a three body recombination early in the afterglow ($k_n = 2.8 \cdot 10^{16}$ cc²/mol² sec, $p = 0.89$ mm Hg, (N) $\sim 2 \cdot 10^{-4}$ mm Hg partial pressure) and exponential decay during the later stages of the afterglow ($\tau = 30$ sec, $p = 0.89$ mm Hg, (N) $\sim 2 \cdot 10^{-5}$ mm Hg, accommodation coefficient $\sim 10^{-5}$); (2) the nitrogen first positive band radiation also decays exponentially but with a decay constant unrelated to that of the atoms; (3) the rate constant k_1 for the production of the nitrogen first positive band emission is $k_1 = 1.6 \cdot 10^{14}$ cc²/mol² sec derived from the early three body decay. Using this value for k_1 , the observed atomic concentration during the exponential decay would produce less emission than observed.

WAU.07:001 - WAU.07:003

WAU.07:001

Washington U. [Dept. of Physics] Seattle.

THE DEUTERON MAGNETIC RESONANCE SPECTRUM AND RELAXATION IN KD_2PO_4 , by J. L. Bjorkstam and E. A. Uehling. [1958] 1v. incl. diagrs. refs. (AFOSR-TN-58-996) (AF 49(638)92; continuation of AF 18(600)653) AD 205902 Unclassified

Presented at meeting of the Amer. Phys. Soc., Stanford U., Calif., Dec. 19-21, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 383-384, Dec. 19, 1957.

Also published in Phys. Rev., v. 114: 961-968, May 15, 1959.

The electric field gradient (EFG) tensor at the site of the deuteron in the hydrogen bond of KD_2PO_4 and the relaxation times of the deuteron were studied. The measured quadrupole coupling constant is 119 kc/sec, the asymmetry parameter is 0.049, and the major principal axis of the tensor is along the bond direction. None of these features of the EFG tensor change appreciably with temperature over the entire range studied, which range includes the ferroelectric Curie point T_c . An interesting additional splitting in the spectral lines below T_c is observed, however. The thermal relaxation time of the deuteron was studied carefully only at room temperature. One obtains $T_1 = 6.5$ min at a particular orientation of the crystal decreasing by a factor of 2 at other particular orientations. T_2 is of the order 5×10^{-4} sec. From the point of view of orientation of the EFG tensor there are 2 distinct kinds of deuterons in the crystal. At any given orientation these deuterons differ in resonance frequency but not in the magnitude of their relaxation times or in their saturation behavior. This interdependence of the 2 kinds of deuterons and the possible causes of relaxation are discussed. (Contractor's abstract)

WAU.07:002

Washington U. [Dept. of Physics] Seattle.

NUCLEAR SPIN-LATTICE RELAXATION IN KH_2PO_4 (Abstract), by J. L. Bjorkstam and E. A. Uehling. [1958] [1]p. [AF 49(638)92] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 166, May 1, 1958.

Studies of the relaxation time in the deuterated form of potassium dihydrogen phosphate have suggested a re-examination of the relaxation in the nondeuterated form. Measurements made by Newman (Jour. Chem. Phys., v. 18: 669, 1950) on the proton relaxation were interpreted by him in terms of a random jump process. He obtained relaxation times for protons equal to 1.6 sec and 0.25 sec, respectively, for crystals of KH_2PO_4 and KH_2AsO_4 . The present study resulted in relaxation times equal to 30 sec and 85 sec, respectively, under the same conditions of temperature and frequency. The phosphorus relaxation time in KH_2PO_4 , and in the deuterated form, was found to be longer. The proton relaxation showed a very striking frequency dependence. In KH_2AsO_4 , T_1 varied linearly from 32 sec at 10 mc/sec to 112 sec at 40 mc/sec. An interpretation of these results is given.

WAU.07:003

Washington U. [Dept. of Physics] Seattle.

FREQUENCY DEPENDENCE OF THE NUCLEAR SPIN-LATTICE RELAXATION (Abstract), by E. A. Uehling and J. L. Bjorkstam. [1958] [1]p. [AF 49(638)92] Unclassified

Presented at meeting of the Amer. Phys. Soc., British Columbia U., Vancouver (Canada), Aug. 26-28, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 318, Aug. 28, 1958.

The relaxation time T_1 of spin 1/2 nuclei in certain crystals of KH_2PO_4 and KH_2AsO_4 is linearly dependent on frequency over a wide range of frequencies. In one case studied so far the ratio of the frequency coefficients for different nuclei in the same crystal has been obtained. In one crystal of KH_2PO_4 the relaxation time increased at the rate of 0.5 sec per mc/sec for the protons and 6.0 sec per mc/sec for the phosphorus. A semiquantitative explanation of the observed facts can be given if we make the following assumptions: (a) relaxation is due to the presence of a small density of paramagnetic ions as first proposed by Bloembergen; (b) the thermal relaxation time T_{1e} of the paramagnetic ions fulfills the condition $T_{1e} \ll 1/\nu_0$ for the smallest nuclear resonance frequency ν_0 . Under these conditions the effective volume of the region surrounding the paramagnetic ion into which spin energy must be transported by diffusion varies inversely as the frequency. Numerical analysis is required in order to explain the dependence of the frequency coefficient on the gyromagnetic ratios and crystal structure.

WAY.03:001

Wayne State U. [Dept. of Mathematics] Detroit, Mich.

NOTES ON INTEGRATION I: THE UNDERLYING CONVERGENCE THEOREM, by W. F. Eberlein. [1957] [4]p. (AFOSR-TN-57-140) (AF 18(600)1534) AD 120497 Unclassified

Also published in Communications on Pure and Appl. Math., v. 10: 357-360, Aug. 1957.

Let C denote the real-valued continuous functions on a compact Hausdorff space S . An integral over S is a positive linear functional on C , that is, a mapping I of C into the real numbers. The theorem states: Let $\lim_{n \rightarrow \infty} f_n = f$ pointwise (f_n, f in C) and $|f_n| \leq M < \infty$ for all n . Then $\lim_{n \rightarrow \infty} I(f_n) = I(f)$. Although the theorem concerns only continuous functions on S , it is a natural basis for extending I . A new and elementary proof of the general theorem is included. It is the basis of a neogeometric approach to integration over function spaces with applications to numerical analysis and physics.

WAY.03:002

Wayne State U. [Dept. of Mathematics] Detroit, Mich.

GENERALIZED HARMONIC ANALYSIS, by W. F. Eberlein. Final rept. July 1, 1956-June 30, 1957, 5p. (AF 18(600)1534) Unclassified

Research results obtained on integration theory, and numerical integration and approximation (the quadrature problem, asymmetric quadrature formulae, discrete approximation, the average error and an integral over function space are some of the topics considered here) are discussed. The work summarized is for the period July 1, 1956-June 30, 1957.

WAY.04:001

Wayne State U. Dept. of Mathematics, Detroit, Mich.

THE SPACES $K(n,p)$, by S. I. Goldberg. Sept. 20, 1957 [15]p. (AFOSR-TN-57-644) (AF 49(638)14) AD 136630 Unclassified

Abstract published in Proc. Fourth Canadian Math. Congress, Banff, Alberta (Canada) (Sept. 1-7, 1957), Toronto, Toronto U. Press, 1959, p. 87.

An n -dimensional differentiable manifold V_n of class C^k ($k \geq 3$) is considered on which there is given a positive definite metric $ds^2 = g_{jk} dx^j dx^k$, $g_{jk} = g_{kj}$, and a connection E_{jk}^i with respect to which the metric

is covariant constant. The torsion tensor is denoted by S_{jk}^i where $S_{jk}^i = 1/2(E_{jk}^i - E_{kj}^i)$. The covariant torsion tensor (tensor of type $(0,3)$) is antisymmetric and the symmetric part of E_{jk}^i coincides with the Christoffel symbols. It is shown that the characteristics of the space, including its Lie group, tensor symmetry, etc. properties define the geometry of a $K(n,3)$ as the natural generalization of the local geometry of a compact semi-simple Lie group.

WAY.04:002

Wayne State U. Dept. of Mathematics, Detroit, Mich.

ON CHARACTERIZATIONS OF THE EUCLIDEAN SPHERE, by S. I. Goldberg. Apr. 1958, 13p. (AFOSR-TN-58-451) (AF 49(638)14) AD 158257; PB 155159 Unclassified

Also published in Nederl. Akad. Wetensch. Proc., Indag. Math., Ser. A., v. 62: 384-390, 1959.

Stressing the relations between differential geometry and elliptic differential equations, the author gives proofs for two well-known theorems, due to H. Hopf: A closed orientable analytic surface of genus zero and constant mean curvature is a sphere. The only closed analytic special Weingarten surfaces of genus zero are spheres. The latter follows from a more general statement (theorem 3) of the author. (Math. Rev. abstract)

WAY.04:003

Wayne State U. Dept. of Mathematics, Detroit, Mich.

A NOTE ON A THEOREM OF MATSUSHIMA AND YANO, by S. I. Goldberg. Oct. 1958, [6]p. (AFOSR-TN-58-954) (AF 49(638)14) AD 205347; PB 140037 Unclassified

The results of Y. Matsushima (Nagoya Math. Jour., v. 11: 146-150, 1957) and K. Yano (Nagoya Math. Jour., v. 12: 147-150, 1957) are generalized. A simplification for the following proof is presented: In a compact Kaehler-Einstein manifold, a contravariant analytic vector field u may be expressed as a sum $v + Cw$, where v and w are Killing vector fields and C is the tensor field (of type $(1,1)$) defining the complex structure. (ASTIA abstract)

WAY.04:004

Wayne State U. Dept. of Mathematics, Detroit, Mich.

AFFINE TRANSFORMATIONS IN A QUATERNION

WAY.05:001-003; WAY.06:001

MANIFOLD, by S. I. Goldberg. Nov. 1958, 12p.
(AFOSR-TN-58-1048) (AF 49(638)14) AD 206755;
PB 140034 Unclassified

Let M be an irreducible almost complex manifold of real dimension $n = 2m$ and denote by $F = (F^i_j)$ the tensorfield defining the almost complex structure. If m is even ($m = 2l$) and the restricted homogeneous holonomy group H_p at $p \in M$ is a subgroup of the real representation $QL(X, R)$ of the quaternion linear group $QL(X, C)$ then M has a quaternion structure. The group of affine transformations $A(M)$ of M is a Lie group and acts on the vector space spanned by those tensorfields of type $(1, 1)$ defining the quaternion structure as a group of rotations of 3-space. It is denoted by $C_F(M)$ the group of all affine transformations preserving F and by $Q(M)$ the subgroup of $C_F(M)$ consisting of those transformations preserving the quaternion structure. Then $C_F(M)$ is a closed subgroup of $A(M)$ and $Q(M)$ is a closed normal subgroup of $A(M)$ and $C_F(M)$. These groups are Lie groups. The main purpose is to show that $A(M)/Q(M)$ is isomorphic to $SO(3)$, if and only if, $Ap(M)$ acts as the full group of automorphisms at the algebra. Various conditions ensure this, such as (1) the factor group $C_F(M)/Q(M)$ is isomorphic to the circle group and (2) the underlying space of $A(M)/Q(M)$ can be identified with projective 3-space.

WAY.05:001

Wayne State U. Dept. of Mathematics, Detroit, Mich.

REFLECTION LAWS OF DIFFERENTIAL EQUATIONS OF MIXED TYPE, by Y. W. Chen. [1957] 25p. (AF 49(638)107) Unclassified

Presented at meeting of the Amer. Math. Soc., New York, Apr. 5-6, 1957.

Consider first the equation $(*) x^s u_{yy} + u_{xx} = 0$ with positive exponent s . The following theorem holds: Let $u(x, y)$ be a solution of $(*)$ of class C_2 in a domain $0 < x < 1$, $a < y < b$, with continuous first and mixed second derivatives on $x = 0$. Let $u(0, y) = T_0(y)$ and $u_x(0, y) = T_1(y)$. Then (1) T_0 and T_1 uniquely determines the solution $u(x, y)$; and (2) when one of the T_i , $i=0, 1$, is zero, the other one is necessary to an analytic function of y , and $u(x, y)$ can be extended to an analytic function of two complex variables. Secondly, the same equation is considered with negative $s > -1$. Under the additional assumption that u_{xy} is continuous for $0 < x < 1$ and on $x = 0$, the above mentioned theorem is valid also in this case. The theorem generalizes the classical reflection principle of harmonic functions ($s = 0$).

WAY.05:002

Wayne State U. [Dept. of Mathematics] Detroit, Mich.

HOELDER CONTINUITY AND INITIAL VALUE PROBLEMS FOR MIXED TYPE EQUATIONS, (I), by Y. W. Chen. [1958] 34p. incl. refs. (AFOSR-TN-58-607) (AF 49(638)107) AD 162135 Unclassified

The existence and functional behavior of solutions $z(W)$ with Hoelder continuous initial values on an open segment l of the y -axis are investigated. Let D be a convex domain in the positive X -half plane with l as a boundary line. Let closed subdomain D' of D be a domain which has a closed subsegment of l as a boundary and which lies otherwise in the interior of D . Take a point on l as $W = 0$. The following theorem is proved: to each regular analytic function $g(W)$ in D with the properties (1) $g(0) = 0$, and (2) in every D' $g(W)$ is Hoelder continuous with exponent μ , $0 < \mu < 1 - \alpha$, there is a solution $z(W)$ in D with the properties (1) $z(W) = 0$, and (2) $s^{-\alpha} u(W)$ and $s^{\alpha} v(W)$ are Hoelder continuous in D' respectively with exponents $\mu - \alpha$ and $\mu + \alpha$. Conversely to each solution $z(W)$ with the two properties just mentioned there is an analytic function $g(W)$ as described above. The initial values of the corresponding functions $g(W)$ and $z(W)$ are related by a simple transformation formula. By a simple device the theorem can be extended to cover the cases $0 < \mu < \alpha$ and $1 - \alpha < \mu < 1$ and also the cases of differentiable or only integrable initial data. (Contractor's abstract)

WAY.05:003

Wayne State U. [Dept. of Mathematics] Detroit, Mich.

HOELDER CONTINUITY AND INITIAL VALUE PROBLEMS FOR MIXED TYPE EQUATIONS (II), by Y. W. Chen. [1958] 19p. incl. refs. (AFOSR-TN-58-698) (AF 49(638)107) AD 162232 Unclassified

A proof is given that the initial value of u belongs to $Lip V$ and, consequently that its conjugate v^* has initial values belonging to $Lip V + 2\alpha$, and conversely. On the basis of the generalized main theorem given, the statement is equivalent to a theorem on analyticity. If $u = 0$ on the initial line and is continuous up to the boundary, then the conjugate v^* is shown to have analytic initial values. The equation $U(x, y) = u_h(x_1, y)$ for $x < 0$ with odd integer exponent p is considered and a theorem on analytic continuation is proved.

WAY.06:001

Wayne State U. Dept. of Mathematics, Detroit, Mich.

ALGEBRAIC LOCAL INVARIANTS OF TOPOLOGICAL

WAY.06:002; WAY.07:001; WEI.01:001

SPACES, by S.-T. Hu. Feb. 1958, 72p. incl. refs.
(AFOSR-TN-58-117) (AF 49(638)179) AD 152025
Unclassified

Also published in *Compositio Math.*, v. 13: 173-218,
1958.

The local homology groups and the local homotopy groups of a topological space X at a point $x_0 \in X$ are defined as the (global) homology groups and the (global) homotopy groups of the tangent space $T(X, x_0)$ which is constructed. It is shown that if X is locally triangulable at x_0 , or more generally, if x_0 is a conic point of X , then these groups are isomorphic to those of Griffiths and Seifert-Threlfall. The homotopy classification is developed for an application of the local invariants to local maps and a local version of the Hopf theorem is proved. These local invariants are used to study the fibre spaces with singularities in the sense of Montgomery and Samelson, or Seifert. An application to topological semi-groups is given.

WAY.06:002

Wayne State U. Dept. of Mathematics, Detroit, Mich.

ON FIBERINGS WITH SINGULARITIES, by S.-T. Hu.
Aug. 1958, 32p. incl. diagrs. (Technical note no. 2)
(AFOSR-TN-58-611) (AF 49(638)179) AD 162139
Unclassified

Also published in *Mich. Math. Jour.*, v. 6: 131-149, 1959.

The paper provides a general definition of fiberings with singularities which includes all of the known fiberings as special cases. The singular fibers identified to points are used to prove that every fibering p with singularities can be decomposed into the composition $p_1 \circ p_2$ of two fiberings p_1 and p_2 where every singular fiber of p_1 is a singleton and every regular fiber of p_2 is a singleton and the natural projection of some topological identification. The singular fiber is studied in the extended tangent space $E(X, x_0)$ of a given space X at a given point x_0 and the natural projection $p: E(X, x_0) \rightarrow X$. The local property of any given fibering $f: X \rightarrow Y$ at an isolated singular fiber x_0 is investigated and it is proved that the fibering axiom of the local homotopy groups holds for every fibering with a single normal singular fiber.

WAY.07:001

Wayne State U. Dept. of Physics, Detroit, Mich.

PREPARATION OF THIN SINGLE-CRYSTAL SEMI-

CONDUCTOR FILMS BY PHOTOELECTRIC ETCHING,
by W. A. Albers, Jr. and J. E. Thomas, Jr. July 22,
1958 [28]p. incl. diagrs. (Technical rept. no. 1)
(AFOSR-TN-58-643) (AF 49(638)158) AD 162175;
PB 138981
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., May 1-3, 1958.

Abstract published in *Bull. Amer. Phys. Soc.*, Series II,
v. 3: 219, May 1, 1958.

A method is described which was developed for preparing thin single-crystal semiconductor films of uniform thickness, the crystalline properties of which are the same as those of the bulk single crystal. Single crystal n-type germanium films of thickness from 3 to 10 μ have been prepared which have thickness variations from 20 to 50% for the thicker and thinner samples, respectively. Expectations are that any semiconductor will exhibit electrolytic-etching properties similar to those of anodic n-type germanium provided the following criteria are met: (1) The rate limiting process for the electrode reaction is the flow of minority carriers to the semiconductor-electrolyte interface; and (2) the net electrode reaction is the etching of the semiconductor material. Thin films of n-type germanium were made that exhibited surprisingly good uniformity with the photoelectric etching technique.

WEI.01:001

Weizmann Inst. of Science, Rehovot (Israel).

PROTON RELAXATION IN WATER, by S. Melboom,
Z. Luz, and D. Gill. [1957] [2]p. incl. diagr. (AF 61-
(052)03)
Unclassified

Published in *Jour. Chem. Phys.*, v. 27: 1411-1412,
Dec. 1957.

Longitudinal and transverse proton relaxation times, T_1 and T_2 respectively, have been measured as a function of the solution pH and a model is presented in which hydrogen bond formation contributes to the value of T_2 . The measured values of T_2 lie consistently below those of T_1 which is inconsistent with the calculated values except for an expected minimum at pH value of 7. The minimum in the theoretical curve, as matched by experiment, is due to the formation and breaking of hydrogen bonds between the water molecules of the solution. No explanation is given of the difference between calculations and experiment at both low and high values of the pH.

WEI.01:002 - WEI.01:006

WEI.01:002

Weizmann Inst. of Science, Rehovot (Israel).

KINETICS OF HYDROGEN EXCHANGE BETWEEN HYDROGEN PEROXIDE AND WATER STUDIED BY PROTON MAGNETIC RESONANCE, by M. Anbar, A. Loewenstein, and S. Meiboom. [1958] 14p. illus. (AFOSR-TN-58-169) (AF 61(052)03) AD 152196

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 80: 2630-2634, June 5, 1958.

The kinetics of hydrogen exchange between H_2O_2 and water have been investigated using the PMR method in the pH range of 2.5 and 6.5. The reaction was found to be both acid and base catalyzed. In the acid region, pH < 4.5, the reaction involves H_3O^+ and H_2O_2 , while in the basic region it was found to involve HO_2^- , H_2O_2 , and H_2O . The reaction constants are $k = 1.6 \times 10^7 \text{ l mol}^{-1} \text{ sec}^{-1}$, and $k = 7.3 \times 10^7 \text{ l mol}^{-2} \text{ sec}^{-1}$, respectively.

WEI.01:003

Weizmann Inst. of Science, Rehovot (Israel).

RESEARCH IN THE GENERAL FIELD OF EXCHANGE KINETICS. INVESTIGATIONS OF FAST PROTOPLYSIS REACTIONS BY THE NUCLEAR MAGNETIC RESONANCE TECHNIQUE. Final rept. July 1958, 70p. incl. diagrs. tables, refs. (AFOSR-TR-58-110) (AF 61(052)-03) AD 201858; PB 142163

Unclassified

The measurement of fast hydrogen exchange rates by the nuclear magnetic resonance technique is described. In the systems studied, the exchangeable hydrogens are bonded either to nitrogen (amine and amide groups) or to oxygen (hydroxyl groups). In many cases, a complete analysis of the kinetics of the exchange reaction was possible. The kinetics of hydrogen exchange was studied in the following systems: (1) aqueous solutions of ammonium chloride; (2) aqueous solutions of N-methylacetamide; (3) aqueous solutions of glycine, glycine methyl ester and sarcosine; (4) proton transfer in water; (5) aqueous solutions of hydrogen peroxide; and (6) ethanol - water mixtures. (Contractor's abstract)

WEI.01:004

Weizmann Inst. of Science, Rehovot (Israel).

A MODIFIED SPIN-ECHO METHOD FOR MEASURING NUCLEAR RELAXATION TIMES, by S. Meiboom and D. Gill. [1958] [12]p. incl. diagrs. (Bound with its AFOSR-TR-58-110; AD 201858) (AF 61(052)03) Unclassified

Also published in Rev. Scient. Instruments, v. 29: 688-691, Aug. 1958.

A spin echo method adapted to the measurement of long nuclear relaxation times (T_2) in liquids is described.

The pulse sequence is identical to the one proposed by Carr and Purcell, but the rf of the successive pulses is coherent, and a phase shift of 90° is introduced in the first pulse. Very long T_2 values can be measured without appreciable effect of diffusion. (Contractor's abstract)

WEI.01:005

Weizmann Inst. of Science, Rehovot (Israel).

STUDY OF THE PROTOPLYSIS KINETICS OF AMMONIUM ION IN AQUEOUS SOLUTION BY THE PROTON MAGNETIC RESONANCE TECHNIQUE, by S. Meiboom, A. Lowenstein, and S. Alexander. [1958] [5]p. (Bound with its AFOSR-TR-58-110; AD 201858) (AF 61(052)03) Unclassified

Also published in Jour. Chem. Phys., v. 29: 969-970, Oct. 1958.

The protolysis kinetics were evaluated from measurements of the proton magnetic resonance line widths of the NH_4^+ triplet (due to N_{14} hyperfine structure) and water lines, as a function of pH value and ammonium ion concentration.

WEI.01:006

Weizmann Inst. of Science, Rehovot (Israel).

HYDROGEN EXCHANGE IN ETHANOL, by S. Meiboom, Z. Luz, and D. Gill. [1958] [9]p. incl. diagrs. table. (Bound with its AFOSR-TR-58-110; AD 201858) (AF 61(052)03) Unclassified

The rate of exchange of the hydroxyl proton in alcohols is very fast, and for this reason cannot be measured by isotope labelling. This exchange reaction can be studied by the NMR technique, and some qualitative results have been published by Arnold (Phys. Rev., v. 102: 136, 1956), and by Weinberg and Zimmerman (Jour. Chem. Phys., v. 23: 748, 1955). The reaction is both acid and base catalyzed. Concentrations of the order of 10^{-5} M acid or base accelerate the reaction to a rate corresponding to a lifetime of the alcohol molecule of about 10^{-2} sec, which is about the highest rate that can be measured by the NMR technique. Quantitative measurements of the hydrogen exchange in ethanol containing different amounts of water are described.

WEI.01:007; WEI.02:001, 002

WEI.01:007

Weizmann Inst. of Science, Rehovot (Israel).

NUCLEAR MAGNETIC RESONANCE STUDY OF THE EXCHANGE KINETICS IN THE ACETIC ACID-ACETIC ANHYDRIDE SYSTEM, by M. Sheinblatt and S. Meiboom. [1958] 15p. incl. refs. (AF 61(052)03) Unclassified

The kinetics of the acetyl exchange reaction in acetic acid-acetic anhydride mixtures has been investigated by the NMR technique. The reaction is strongly acid-catalyzed. The reaction rate is first order in respect to hydrogen ion concentration and increases with acetic anhydride concentration. The average lifetime between exchanges is about 0.02 sec in a solution having equal concentrations of acetic acid and acetic anhydride, and containing 0.1 mol l^{-1} perchloric acid. A discussion of the possible exchange mechanisms is given. It is concluded that the dominant mechanism is a reaction between the $AcOH_2^+$ ion and the acetic anhydride molecule. (Contractor's abstract)

WEI.01:008

Weizmann Inst. of Science, Rehovot (Israel).

NUCLEAR MAGNETIC RESONANCE STUDY OF THE PROTOLYSIS AND IONIZATION OF N-METHYLACETAMIDE, by A. Berger, A. Loewenstein, and S. Meiboom. [1958] [23]p. incl. diagrs. table, refs. (Bound with its AFOSR-TR-58-110; AD 201858) (AF 61(052)03) Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 62-67, Jan. 5, 1959.

The rate and mechanism of protolysis in N-methylacetamide in aqueous solution has been investigated by the nuclear magnetic resonance technique. The protolysis was found to be both acid and base catalyzed, the reaction rate being proportional to the amide concentration and to the hydrogen ion or hydroxyl ion concentration. It was found that in N,N-dimethylacetamide, free rotation around the C-N bond occurs on acidification. This phenomenon is closely related to the protolysis in N-methylacetamide, both being due to protonation at the nitrogen atom. It could be shown, however, from a study of the NMR spectrum in very acidic solution, that the protonation occurs predominantly at the oxygen, both ionic species being in equilibrium. A detailed mechanism for the exchange reactions is proposed. (Contractor's abstract)

WEI.01:009

Weizmann Inst. of Science, Rehovot (Israel).

PROTOLYSIS OF GLYCINE AND GLYCINE DERIVA-

TIVES, by S. Meiboom and M. Sheinblatt. [1958] [11]p. incl. diagrs. (Bound with its AFOSR-TR-58-110; AD 201858; [AF 61(052)03]) Unclassified

The hydrogen exchange has been investigated in aqueous solutions of the following compounds: (1) glycine (H_2NCH_2COOH); (2) glycine methyl ester ($H_2NCH_2COOCH_3$); and (3) sarcosine (N-methyl-glycine) ($H_3CHN_2^+CH_2COOCH$). In very acidic solutions the exchange in these compounds becomes slow enough for measurement by the NMR technique. This occurs above about 1N HCl for glycine and glycine methyl ester, and above 0.1N for sarcosine. Typical spectra of these compounds in very acidic solution are given. The amine hydrogen lines are very broad because of quadrupole relaxation of the N^{14} nucleus, and are not reproduced in this report. These lines are too broad and weak to be useful in the rate determinations.

WEI.02:001

Weizmann Inst. of Science. Dept. of Applied Mathematics, Rehovot (Israel).

SOLUTION OF AN INTEGRAL EQUATION OCCURRING IN IMPULSIVE WAVE PROPAGATION PROBLEMS, by C. L. Pekeris. May 6, 1956 [5]p. incl. refs. (AFOSR-TN-57-79) (AF 61(514)899) AD 120425 Unclassified

Also published in Proc. Nat'l. Acad. Sciences, v. 42: 439-443, July 1956.

An integral equation solution for impulsive wave propagation problems in which the disturbance is propagated in a doubly or multiply refracted media is given. A summarized analysis of the equation is presented to facilitate solutions of related wave problems:

$$p \int_0^\infty e^{-pt} W(t, r, H) dt = \frac{p}{c} \int_0^\infty J_0 \left(\frac{p}{c} rx \right) f(x) e^{-(p/c)H\sqrt{x^2 + a^2}} x dx.$$

Here p = operation ($\partial/\partial t$), c = characteristic velocity of propagation of the medium, r = horizontal distance in cylindrical coordinates, H = depth of the source, J_0 = Bessel function of order zero, $f(x)$ is given, and W to be determined. Five case studies of the types of problems met illustrate the usage.

WEI.02:002

Weizmann Inst. of Science. Dept. of Applied Mathematics, Rehovot (Israel).

RADIATION DUE TO AN IMPULSIVE CURRENT IN A VERTICAL ANTENNA PLACED ON A DIELECTRIC

WES.01:002; WRU.01:001-003

GROUND, by C. L. Pekeris and Z. Alterman. Technical rept. Nov. 1, 1955-Oct. 31, 1956, 19p. diagrs. (AFOSR-TN-57-247) (AF 61(514)899) AD 126545 Unclassified

Also published in Jour. Appl. Phys., v. 28: 1317-1323, Nov. 1957.

Study is made of the electromagnetic field generated by passing an impulsive current of the form of a delta function $\delta(t)$ through a vertical antenna placed on a dielectric ground. The problem is formulated in operational form, and the Hertzian potential π is expressed as an integral over a Bessel function. This operational solution is then inverted, and the Hertzian potential $\pi(r, z, t)$ is expressed in terms of finite complex integrals over a fixed range. The integrals for π are evaluated on the electronic computer of the Weizmann Institute, and the results for the case of a dielectric constant $\epsilon = 9$ are given. The field in the air starts with a finite value at the time of arrival of the wave front, and then increases in a monotone fashion toward the steady state value. In the ground, there is a cone of angle $\sin^{-1}(1/\sqrt{\epsilon})$ centered around the downward vertical, inside which the field starts again with a finite value and then decreases toward the steady state value. Outside this cone, the direct wave in the ground is preceded by a diffracted wave originating from secondary radiation emanating from the portion of the boundary where the air wave passed in advance of the ground wave. This diffracted wave starts with zero amplitude and increases thereafter, becoming logarithmically infinite at the time of arrival of the direct wave in the ground. After that the amplitude decreases continuously toward the steady state value.

WES.01:002

Wesleyan U. Dept. of Chemistry, Middleton, Conn.

STUDY OF THE FORMATION AND DEVELOPMENT OF THE LATENT IMAGE IN PHOTOGRAPHY, by J. Gomez-Ibanez. Final rept. July 1958, iv. incl. diagrs. tables, refs. (AFOSR-TR-58-93) (AF 18(600)343) AD 162134 Unclassified

This final report summarizes the work done under this contract which deals with the study of latent image formed upon exposing to light sols of silver bromide. No attempt has been made to draw conclusions from the data obtained, which, although extensive, should be considered still incomplete. One important conclusion can nevertheless be inferred from the present work: the latent image obtained in silver bromide sols does not seem to consist of metallic silver as previously postulated, but rather it appears to be a colloidal silver complex.

WRU.01:001

Western Reserve U. Dept. of Physics, Cleveland, Ohio.

EVALUATION OF TWO-CENTER EXCHANGE INTEGRALS, by G. E. Tauber. Dec. 1957, 34p. incl. tables, refs. (AFOSR-TN-57-799) (AF 18(603)61) AD 148031 Unclassified

Also published in Jour. Chem. Phys., v. 29: 300-310, Aug. 1958.

The evaluation of two-center exchange integrals for any homonuclear molecules using Slater-type wave functions is reduced to the solution of Poisson's equation. An expression is obtained for the exchange integrals in terms of integrals which can be evaluated analytically. In particular, all cases which arise from 2s and 2p wave functions are discussed in detail and the auxiliary integrals evaluated. The pertinent results are collected in tables, and the final result for a particular exchange integral is given explicitly. (Contractor's abstract)

WRU.01:002

Western Reserve U. Dept. of Physics, Cleveland, Ohio.

ROTATIONAL MAGNETIC MOMENT OF H_2 , by G. E. Tauber. July 8, 1958, 17p. incl. diagrs. refs. (AFOSR-TN-58-571) (AF 18(603)61) AD 158390 Unclassified

Also published in Phys. Rev., v. 112: 866-869, Nov. 1, 1958. (Title varies)

The rotational magnetic moment of H_2 has been calculated by considering the motion of the electrons in the presence of the two nuclei which are permitted to move themselves. The interaction is described by Breit's two-body Hamiltonian suitably generalized to this problem. The wave function is obtained by the Born-Oppenheimer method of adiabatic approximation. Calculations have been carried out for Wang's electronic wave function and up to first order in the expansion parameter give for the effective magnetic field due to rotation 23.6 gauss in good agreement with the experimental results of 27.0 gauss. (Contractor's abstract)

WRU.01:003

Western Reserve U. Dept. of Physics, Cleveland, Ohio.

ACOUSTIC DELAY LINE MEMORY FOR HUTCHINSON-SCARROTT KICKSORTER, by B. L. Robinson. Dec. 8, 1958 [5]p. incl. diagrs. (AFOSR-TN-58-1033) (AF 18(603)61) AD 206483; PB 140035 Unclassified

The multiple channel pulse height analyzer (kicksorter) introduced by Hutchinson and Scarrott stores the numerical results of the pulse height analysis in a serial

WRU.02:001 - WRU.02:005

type computer memory commonly called the acoustic delay line memory. A quartz delay line memory unit was developed which includes transmitter, receiver and pulse shaping circuits in an inexpensive and compact plug-in package. The unit operates at a clock rate of 1.00 mcps, and requires clock pulses and input signals (about 10 v in amplitude and clamped to a reference voltage). Shaped output pulses of the same character are produced by the memory unit. This unit was adapted to the kicksorter. In the kicksorter, the clock oscillator is gated by the sweep circuit, and therefore clock pulses are not available until the sweep has started. The sweep must be started and synchronized by the output of the memory. The necessary signal is derived from output of the receiver through an amplifier stage.

WRU.02:001

Western Reserve U. School of Library Science,
Cleveland, Ohio.

MECHANIZED SEARCHING EXPERIMENTS USING THE WRU SEARCHING SELECTOR, by J. Rees and A. Kent. May 15, 1958, 31p. (Technical note no. 1) (AFOSR-TN-58-445) (AF 49(638)357) AD 158250 Unclassified

Also published in Amer. Documentation, v. 9: 277-303, Oct. 1958.

An outline is given of the pilot search system established to test the pertinency of the abstracts retrieved in response to requests for information from the store of about 10% of the metallurgical literature of 1955. Duplications of the information and correspondence forms sent to potential requestors and those used to determine the satisfaction of the requestor of the supplied information are given. Case study examples (17) are given to illustrate the questions presented and the abstracts produced from the store.

WRU.02:002

Western Reserve U. School of Library Science,
Cleveland, Ohio.

SUBJECT MATTER ANALYSIS AND CODING. SOME FUNDAMENTAL CONSIDERATIONS, by J. W. Perry. May 29, 1958, 43p. incl. diagr. tables, refs. (Technical note no. 2) (AFOSR-TN-58-501) (AF 49(638)357) AD 158311; PB 134516 Unclassified

Also published in Punched Cards, 2nd ed., ed. by R. S. Casey, J. W. Perry and others. N. Y., Reinhold, 1958, p. 391-422.

In applying various devices and types of equipment to search, to select and to correlate recorded information, the latter's characteristics as well as the scope of information requirements to be serviced must be expressed by a common code. Its design is of decisive

importance both in meeting the requirements that are made of an information system and in keeping costs at the lowest possible level. Other things being equal the simplest code that is effective in meeting requirements is to be preferred. Any elements of complexity in a code must justify themselves by providing benefits commensurate with costs. (Contractor's abstract)

WRU.02:003

Western Reserve U. School of Library Science,
Cleveland, Ohio.

NONCONVENTIONAL RETRIEVAL SYSTEMS IN DOCUMENTATION. PRELIMINARY COMPARATIVE ANALYSIS, by A. Kent. June 24, 1958, 25p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-58-575) (AF 49(638)357) AD 158396 Unclassified

A group of 104 nonconventional information retrieval systems are analyzed with regard to a number of basic characteristics in order to discern those features that these systems have in common and those features by which they differ. Two basically different types of systems are identified: document and aspect, and the typical functioning of these types of information retrieval systems is described. A table listing the characteristics of these systems is included. (Contractor's abstract, modified)

WRU.02:004

Western Reserve U. School of Library Science,
Cleveland, Ohio.

SOME STATISTICAL SAMPLING CONCEPTS APPLIED TO THE INFORMATION RETRIEVAL PROCESS OF DOCUMENTATION SYSTEMS, by H. M. Wadsworth and R. B. Booth. Aug. 19, 1958, 36p. incl. diagrs. table. (Technical note no. 4) (AFOSR-TN-58-765) (AF 49(638)357) AD 201864 Unclassified

Statistical sampling theory is used to develop expressions for the probability of retrieval of any number of desired entries from the store of a documentation system. The hypergeometric and binomial distributions for the probability functions are given for the case of non-replacement and replacement of sample items during the course of the search. Approximations by use of the normal and Poisson distributions are given, and examples are calculated to illustrate the degree of approximation.

WRU.02:005

Western Reserve U. School of Library Science,
Cleveland, Ohio.

COMPUTERS AND DOCUMENTATION, by A. Kent.

WRU.03:001; WHE.02:001, 002

Aug. 15, 1958 [34]p. incl. diagrs. refs. (Technical note no. 5) (AFOSR-TN-58-786) (AF 49(638)357)
AD 201865 Unclassified

Presented at Congresso Internacional de Automatica, Madrid U. (Spain), Oct. 13-19, 1958.

The use of computers to perform nonconventional techniques of searching and correlating large files of recorded information is discussed as a solution of the documentation problem. Various problems in the input, output, and correlation phases of machine searches are discussed in terms of a simplified model of an information retrieval system. The analysis and encoding of metallurgical literature for searching with Western Reserve Searching Selector are summarized.

WRU.03:001

Western Reserve U. School of Medicine, Cleveland, Ohio.

BLOOD ACTH: EFFECTS OF ETHER, PENTOBARBITAL, EPINEPHRINE AND PAIN, by P. C. Royce and G. Sayers. [1958] [7]p. incl. tables, refs. (AFOSR-TN-58-466) (AF 18(603)128) AD 158276 Unclassified

Also published in Jour. Endocrinology, v. 63: 794-800, Dec. 1958.

The exogenous test for ACTH release, analysis of blood ACTH in a recipient hypophysectomized rat, provides information on the rapid changes in blood ACTH which may follow application of a stimulus. The endogenous test, analysis of ACTH release by adrenal ascorbic acid depletion in the stimulated animal, fails to uncover these dynamic changes. A painful stimulus markedly elevates blood ACTH within a few minutes of application. Elevated blood levels persist during 30 minutes of intermittent painful stimulation. Ether first excites, then inhibits ACTH release. Pentobarbital exhibits only a depressant action. The excitatory action of ether is blocked by decerebration and by destruction of the median eminence area of the hypothalamus. The excitatory action of epinephrine is manifest in the decerebrates but not in the median eminence lesion rat. Since ether and pentobarbital depress the brain stem reticular system, it is reasonable to speculate that the action of these two agents in inhibiting ACTH release involves this multisynaptic conduction system. The reduction by pentobarbital of blood ACTH below the resting level characteristic of undisturbed adrenalectomized rats suggests that stimuli encountered in everyday existence such as light, sound and touch, exert a tonic action on the pituitary to maintain a low rate of release of ACTH. (Contractor's abstract)

WHE.02:001

Westinghouse Electric Corp. Westinghouse Research Labs., East Pittsburgh, Pa.

THE TRAPPING OF HELIUM IONS AND THE RE-EMISSION OF TRAPPED ATOMS FROM MOLYBDENUM, by L. J. Varnerin and J. H. Carmichael. Feb. 18, 1957, 1v. incl. diagrs. tables, refs. (Scientific Paper no. 6-94436-4-P5) (AFOSR-TN-57-270) (AF 18(600)1049) AD 126571 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 2: 34, Jan. 30, 1957.

Also published in Jour. Appl. Phys., v. 28: 913-919, Aug. 1957.

The electrical cleanup of helium on molybdenum surfaces has been investigated. In this case, the phenomenon can be described by a trapping of ions upon impact with the surface. Measurements of the trapping efficiency η (atoms removed/ions collected) have been made over a range of ion energies from 150 to 2600 ev. The re-emission of trapped helium atoms was investigated in detail. The contribution of re-emission to the pumping process is described by a phenomenological theory. The results indicate that the trapping efficiency is lowered by a short time re-emission of trapped atoms. Through the long time re-emission of atoms, the theory accounts quantitatively for the observed saturation of the cleanup process. (Contractor's abstract)

WHE.02:002

[Westinghouse Electric Corp.] Westinghouse Research Labs., East Pittsburgh, Pa.

TRAPPING OF NOBLE GAS IONS AND THE RE-EMISSION OF THE TRAPPED ATOMS FROM NICKEL AND MOLYBDENUM, by J. H. Carmichael and J. S. Knoll. Sept. 25, 1958 [14]p. incl. diagrs. tables. (Scientific paper no. 6-94439-9-P1) (AFOSR-TN-58-971) (AF 18(600)1049) AD 222512 Unclassified

Also published in Trans. Fifth Nat'l. Symposium on Vacuum Tech., San Francisco, Calif. (Oct. 22-24, 1958), London, Pergamon Press, 1959, p. 18-21.

The electrical cleanup of noble gases on nickel and molybdenum surfaces has been investigated. The re-emission of the trapped atoms has been measured and is shown to be an important factor in the observed saturation of the cleanup process. Pumping speeds and re-emission rates for helium, neon, argon, and krypton have been measured and compared with the

WIS.03:007; WIS.05:001

phenomenological theory which had previously been proposed to explain the contribution of re-emission to the pumping process of helium on molybdenum surfaces. (Contractor's abstract)

WIS.03:007

Wisconsin U. Dept. of Chemistry, Madison.

THE STEREOSPECIFIC RADICAL ADDITION OF HYDROGEN BROMIDE TO CIS- AND TRANS-2-BROMO-2-BUTENE, by H. L. Goering and D. W. Larsen. [1957] 4p. (AFOSR-TN-57-143) (AF 18(800)1037) AD 128432
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 2853-2854, May 20, 1957.

Experiments were conducted to show the stereospecificity of the radical addition of hydrogen bromide in an acyclic system. Mixtures of anhydrous liquid hydrogen bromide with, in one case, cis- and in another trans-2-bromo-2-butene were irradiated, after which the hydrogen bromide was allowed to evaporate and the composition of the residual reaction mixture determined by gas chromatographic and infrared analysis. That the additions were radical rather than ionic was clear from the orientation. When a mixture of cis-2-bromo-2-butene and liquid hydrogen bromide was allowed to stand in the dark at -80° for 1 hr the reaction mixture was found to contain 8.5% of bromobutene and 91.5% 2,2-dibromobutane. Under similar conditions using trans-2-bromo-2-butene the reaction mixture consisted of 10% unreacted bromobutene, 87% 2,2-dibromobutane, and 3% di-2,3-dibromobutane. It was determined from these observations that the radical addition is indeed stereospecific and results in almost complete trans addition.

WIS.03:008

Wisconsin U. Dept. of Chemistry, Madison.

ADDITION OF HYDROGEN BROMIDE TO 1-HALOCYCLOHEXENE AND THE REARRANGEMENT OF DIHALOCYCLOHEXANES IN THE PRESENCE OF FERRIC CHLORIDE, by H. L. Goering and L. L. Sims. [June 24, 1957] 19p. incl. tables, refs. [Rept. no. 6] (AFOSR-TN-57-280) (AF 18(800)1037) AD 132351
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 6270-6274, Dec. 5, 1957.

The ionic addition of hydrogen bromide to 1-chlorocyclohexene and 1-bromocyclohexene in excess liquid hydrogen bromide in the presence of a small amount of ferric chloride gives 1-bromo-1-chlorocyclohexene and 1,1-dibromocyclohexane, respectively. In the presence of larger amounts of ferric chloride the initially formed gem dihalide undergoes halogen exchange and rearrange-

ment. Thus both 1-chlorocyclohexene and 1-bromocyclohexene can be converted to trans-1,4-dibromocyclohexane in good yields. Examination of products from a series of experiments in which the amount of ferric chloride was varied indicates the following sequence for the conversion of 1-chlorocyclohexene to trans-1,4-dibromocyclohexane: 1-chlorocyclohexene - 1-bromo-1-chlorocyclohexene - 1,1-dibromocyclohexene - cis-1,2-dibromocyclohexane - 1,3-dibromocyclohexane - trans-1,4-dibromocyclohexane. Apparently, trans-1,2-dibromocyclohexane is not involved as an intermediate in this process. Under appropriate conditions 1-chlorocyclohexene can be converted to 1-bromo-1-chlorocyclohexane, 1,1-dibromocyclohexane or trans-1,4-dibromocyclohexane in good yields.

WIS.03:009

Wisconsin U. Dept. of Chemistry, Madison.

THE SOLVOLYSIS OF CIS AND TRANS-2-CHLOROCYCLOALKYL ARYL SULFIDES IN 80% AQUEOUS ETHANOL, by H. L. Goering and K. L. Howe. Sept. 10, 1957, 19p. incl. diagrs. tables, refs. (AFOSR-TN-57-495) (AF 18(800)1037) AD 136485
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 79: 6542-6548, Dec. 20, 1957.

The rates of solvolysis of cis- (Ia) and trans-2-chlorocyclohexyl phenyl sulfide (IIa) and cis- (IIIa) and trans-2-chlorocyclopentyl phenyl sulfide (IVa) and para substituted derivatives of these β -chlorosulfides in 80% aqueous ethanol have been determined. In both the cyclohexyl and cyclopentyl systems the trans isomers, in which the neighboring sulfide group can participate in the ionization step, are more reactive than the corresponding cis isomers by factors of 10^5 to 10^6 . Electron-withdrawing substituents retard the rate of solvolysis of the trans-2-chlorocycloalkyl phenyl sulfides (II and IV) but do not affect the reactivity of the cis isomers (I and III). At 118° the cis-2-chlorocyclohexyl aryl sulfides (I) are 6 times less reactive than cyclohexyl chloride and the cis-2-chlorocyclopentyl aryl sulfides are 15 times less reactive than cyclopentyl chloride. Similar values of ρ_{Hoe} and $k_{\text{trans}}/k_{\text{cis}}$ for the cyclohexyl and cyclopentyl chlorosulfides show that sulfur participates about equally well in the two systems. (Contractor's abstract)

WIS.05:001

Wisconsin U. Dept. of Chemistry, Madison.

THE EFFECT OF SOLVENT ON SPECTRA. 1. A NEW EMPIRICAL MEASURE OF SOLVENT POLARITY: Z-VALUES, by E. M. Kosower. [1958] 8p. incl. diagrs. tables, refs. [AF 49(638)282]
Unclassified

WIS.05:002, 003; WIS.06:001, 002

Published in Jour. Amer. Chem. Soc., v. 80: 3253-3260, July 5, 1958.

The position of the charge-transfer (c-t) absorption band of 1-alkylpyridinium iodide complexes is remarkably sensitive to the nature of the solvent in which it is measured. The transition energies derived from the band positions are linear in the Winstein-Grunwald Y-value (a kinetic measure of solvent ionizing power) over a wide range of methanol-water, ethanol-water and acetone-water mixtures. The c-t bands can be measured in solvents for which it is not possible or convenient to seek a Y-value. It is proposed that the transition energies, in kcal/mol, be adopted as empirical measures of solvent polarity, and that they be called Z-values. The complex formed from 1-ethyl-4-carbomethoxypyridinium iodide was selected as a standard and pyridine-1-oxide was used to extend the Z-value scale to iso-octane, in which the salt is insoluble. As an initial check on the validity of the Z-values, the transition energies for the c-t bands of the 1-ethyl-4-cyanopyridinium iodide complex in six solvents have been found to be linear in Z. A theoretical analysis of the data based on a reasonable model for the 1-alkylpyridinium iodide complex provides the free energy of solution of the complex dipole. The difference in free energy of solution of the 1-ethyl-4-carbomethoxypyridinium iodide complex dipole between iso-octane and water is 17.3 kcal/mol. Using the apparent absorption coefficient as a measure of the effect of the solvent on the association of the pyridinium and iodide ions into complex, it is found that certain solvents (dimethylformamide, dimethyl sulfoxide) are dissociating, and others associating (acetic acid), in comparison with "normal" solvents (chloroform, alcohols, etc.). (Contractor's abstract)

WIS.05:002

Wisconsin U. Dept. of Chemistry, Madison.

THE EFFECT OF SOLVENT ON SPECTRA. II. CORRELATION OF SPECTRAL ABSORPTION DATA WITH Z-VALUES, by E. M. Kosower. [1958] [7]p. Incl. diagrs. tables, refs. [AF 49(638)282] Unclassified

Published in Jour. Amer. Chem. Soc., v. 80: 3261-3267, July 5, 1958.

A number of electronic transitions in different solvents are compared with Z-values, an empirical measure of solvent polarity based on the c-t band of 1-ethyl-4-carbomethoxypyridinium iodide. It is possible to identify certain specific interactions between solute and solvent by this means. With the aid of several reasonable assumptions, and a knowledge of the difference in the free energy of solution of the pyridinium iodide dipole between iso-octane and water, it is possible to estimate the excited state dipole moments resulting from certain electronic transitions. The effect of solvent on the spectra of several cyclopropyl ketones has been investigated, and a band resulting from cyclopropyl conjugation unequivocally identified in this way. Methyl cyclopropyl ketone has a maximum at 1931 Å in water; this information casts doubt on previously reported maxima attributed to the interaction of a cyclopropyl ring with a carbonyl group. (Contractor's abstract)

quievally identified in this way. Methyl cyclopropyl ketone has a maximum at 1931 Å in water; this information casts doubt on previously reported maxima attributed to the interaction of a cyclopropyl ring with a carbonyl group. (Contractor's abstract)

WIS.05:003

Wisconsin U. Dept. of Chemistry, Madison.

THE EFFECT OF SOLVENT ON SPECTRA. III. THE USE OF Z-VALUES IN CONNECTION WITH KINETIC DATA, by E. M. Kosower. [1958] [4]p. Incl. diagrs. table, refs. [AF 49(638)282] Unclassified

Published in Jour. Amer. Chem. Soc., v. 80: 3267-3270, July 5, 1958.

The correlation of solvent effects on reaction rates can be extended to non-hydroxylic solvents with Z-values, which are based on the position of the charge-transfer band of 1-ethyl-4-carbomethoxypyridinium iodide in a given solvent. In the case of the exchange of radioactive iodide ion with methyl iodide, specific interaction between iodide ion and acetone, in the transition state and initial state accounts for the unusually rapid reaction observed in acetone. The Z-value correlations offer an opportunity of separating electrostatic and specific solvent effects. The analogy between the "intimate ion-pair" solvolysis intermediate and the pyridinium iodide complex is discussed, and the value of this point of view is illustrated by application to some data for tri-(p-nitrophenyl)-methyl derivatives. (Contractor's abstract)

WIS.06:001

Wisconsin U. Dept. of Chemistry, Madison.

THE ACID STRENGTH OF TRIPHENYLSILANOL, by R. West and R. H. Baney. July 18, 1958 [2]p. (AFQSR-TN-58-686) (AF 49(638)285) AD 162220 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 7: 297-298, Oct. 1958.

Triphenylsilanol may be titrated in pyridine solution, using tetrabutyl NH₄OH in benzene-methanol as titrant.

The following reproducible half-neutralization voltages are found: phenol-0.68; p-methoxyphenol-0.73; triphenylsilanol-0.80; and p-nitroaniline-0.90; all ± 0.01 v, at 0.01 to 0.02 M. This is the first direct measurement of the Brønsted acidity of a silanol compared to other weak acids.

WIS.06:002

Wisconsin U. Dept. of Chemistry, Madison.

HYDROGEN BONDING OF PHENOLS TO OLEFINS, by

WIS.06:003; WIS.04:004. CC*

by R. West. Sept. 2, 1958 [13]p. incl. diagrs. tables, refs. (AFOSR-TN-58-805) (AF 49(638)285)
AD 202360 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 1614-1617, Apr. 5, 1959.

Evidence was obtained for the formation of weak intermolecular H bonds between phenols and olefins in solution by IR spectral studies in the 3400 to 3800 cm^{-1} region. A new O-H absorption band characteristic of the H-bonded complex appeared at 60 to 130 cm^{-1} lower frequency than the absorption due to unassociated phenol hydroxyl groups. Relative basicities of olefins were measured by determining the frequency shift on H bonding. The basicities were increased by increasing the alkyl substitution at the double bond, and decreased by conjugation. Intramolecular H bonding to ethylenic π -electrons was observed in o-allylphenol. Phenol was used as the principal hydroxyl compound along with the slightly more acidic compound p-fluorophenol. Phenols have the following advantages as reference acids in H bonding studies: (1) the greater acidity of phenols leads to larger shifts of absorption position on H bonding; (2) phenols have a higher absorptivity for O-H vibration, so that the bands in question can be observed conveniently; and (3) phenols have less tendency to self-association than aliphatic alcohols, which minimizes complications resulting from intermolecular association of hydroxyl groups with one another. At 0.20 M or less in CCl_4 the self-association of the phenols used was negligible. (ASTIA abstract)

WIS.06:003

Wisconsin U. Dept. of Chemistry, Madison.

THE REDUCTIVE COUPLING OF TRIPHENYL-CHLOROSILANE: EVIDENCE FOR THE TRIPHENYL-SILYL GRIGNARD REAGENT, by T. G. Selin and R. West. [1958] [2]p. (AFOSR-TN-58-806) (AF 49(638)-285) AD 202361 Unclassified

Also published in Tetrahedron, v. 5: 97-98, Jan. 1959.

A novel coupling of 2 mol of a chlorosilane by a Grignard reagent to produce the Si-Si linkage probably involved the formation of the first known example of an organosilylmagnesium compound. Ph_3SiCl (0.05 mol) refluxed 18 hrs or more with 0.10 mol $\text{C}_6\text{H}_{11}\text{MgBr}$ in 250 ml tetrahydrofuran yielded 67% $\text{Ph}_3\text{SiSiPh}_3$ (I), m 365-6°, together with 1 mol each of cyclohexene (II) and C_6H_{12} . Under the same conditions PhMgBr and 2 - $\text{Me C}_6\text{H}_{10}\text{MgBr}$ gave 51 and 62% yields of I, respectively, though no disilane was obtained in the less basic Et_2O . Me_3SiCl was not coupled under the above

conditions but a mixture of Ph_3SiCl and Me_3SiCl yielded 14% Ph_3SiSiMe , m 106.8°, suggesting the reaction of the intermediate Ph_3SiMgBr with Me_3SiCl .

Apparently aromatic groups on Si are necessary for stabilization of the intermediate as they appear necessary for the formation of organosilylalkali compounds. Ph_3SiCl and $\text{C}_6\text{H}_{11}\text{MgBr}$ may undergo a 4-center reaction with formation of Ph_3SiMgBr , II, and HCl. The Ph_3SiMgBr would couple with Ph_3SiCl and the by-product HCl would react with $\text{C}_6\text{H}_{11}\text{MgBr}$ with formation of C_6H_{12} . This mechanism is consistent with experiments showing that the reduction of Ph_3SiCl to Ph_3SiH is not a part of the coupling reaction, and that the coupling reaction proceeds by a polar rather than a free radical reaction.

WIS.04:004

[Wisconsin U. Dept. of Physics, Madison.]

SMALL-ANGLE X-RAY SCATTERING FROM COLD-WORKED METALS (Abstract), by W. W. Beeman, R. [H.] Neynaber and others. [1957] [1]p. [AF 18(600)698] Unclassified

Published in Acta Crystallographica, v. 10: 825, Dec. 1957.

Studies of the temperature dependence and polarization of the x-ray scattering at small angles from cold-worked Cu, Ni and Al are described. There is very little evidence for cavity scattering except, perhaps in diffusion couples. Most of the scattering can be explained as the result of two successive Bragg scatterings either from two subgrains of the same original grain or a double process within a single subgrain, the resulting forward beam, in this case, being physically broadened. In annealed materials a sharp diffracted beam at angles too small to allow a single Bragg reflection has been observed occasionally. Such diffractions are the result of a double Bragg reflection from two grains accidentally so oriented as to permit the reflection. In cold working the number of independent reflecting domains is greatly increased and the continuous small-angle scattering is assumed to be the unresolved sum of a large number of double scattering processes.

WIS.04:005

Wisconsin U. Dept. of Physics, Madison.

[STUDY OF LATTICE IMPERFECTIONS IN CRYSTALS] by W. W. Beeman. Final rept. Dec. 31, 1958, 3p. (AF 18(600)698) Unclassified

WIS.04:005 (continued)

The true small angle single scattering from cold worked metals is a very small fraction of the observed scattering, which appears at small angles, but which is really the result of two large angle Bragg scatterings successively from two subgrains which are slightly tilted with respect to one another. Therefore, it is not possible to use small angle x-ray scattering as a direct probe of the defect structure of cold worked metals. Long wavelength neutron studies may be useful since the wavelength can be made so great that no Bragg scattering is possible. However, there are intensity difficulties with neutrons. The discovery of the double Bragg scattering mechanism is of considerable

x-ray interest but the possible applications to solid state physics have not been thoroughly explored. The scattering curve gives a measure of the tilt angle distribution of the subgrains in a cold worked grain. Measurement of the rate of disappearance of the scattering at elevated temperatures is a convenient way of studying the kinetics of recovery and recrystallization. Dr. Sharp in his thesis work investigated the small angle scattering from Cu-Ni diffusion couples. In this case there is clear evidence for single scattering from cavities but mixed with it is a quite appreciable amount of double Bragg scattering presumably caused by the lattice distortions which accompany diffusion.



YAL.02:007 - YAL.02:010

YAL.02:007

[Yale U. Dept. of Mathematics, New Haven, Conn.]

THE LEAST EIGENVALUE OF HILL'S EQUATION, by
R. A. Moore. [1957] [14]p. [AF 18(600)1127]

Unclassified

Published in Jour. Analyse Math. (Jerusalem), v. 5:
183-196, 1956/1957.

The functional dependence of the least eigenvalue $(-a)$ of Hill's equation $y'' + (-a + bq(x))y = 0$ on the parameter b is investigated. Here q is a periodic function of period one with mean zero, and y is required to be periodic with period one. By using various Sturmian theorems, the author proves the following and other similar properties of the function $a(b)$: $a(b)$ is convex, $a(0) = a'(0) = 0$, and

$$a(b) \leq \begin{cases} mb - m^2 w^{-2} & (b \leq 2mw^{-2}) \\ \frac{1}{2} w^2 b^2 & (2mw^{-2} \leq b \leq 2Mw^{-2}) \\ Mb - m^2 w^{-2} & (b \geq 2Mw^{-2}) \end{cases}$$

where m and M are the minimum and maximum values of q , while w is the maximum value of

$$\left| \int_{\xi_1}^{\xi_2} q(x) dx \right| \text{ for } 0 \leq \xi_1 \leq \xi_2 \leq 1. \text{ (Math. Rev. abstract)}$$

YAL.02:008

[Yale U. Dept. of Mathematics] New Haven, Conn.

[CAUCHY'S PROBLEM: EXISTENCE AND UNIQUENESS OF THE SOLUTIONS] Problème de Cauchy: existence et unicité des solutions, by E. Hille. [1957] [AF 18(600)1127]

Unclassified

Published in Bull. Math. Soc. Sci. Math. Phys. R. P. Roumaine, v. 1: 31-53, 1957.

Cauchy's abstract problem is studied in a Banach space for reason of precision. The conditions imposed assume A to be a linear operator whose domain $D[A]$ and counterdomain $R[A]$ are subspaces of X , a complex B space. An element f_0 of X is given with the intent of finding an application $t \rightarrow y(t; f_0)$ of $0 \leq t < \infty$ in X such that: (1) $y(t; f_0) \in D[A]$, (2) $y(t; f_0)$ possesses a derivative strongly continuous with respect to t , (3) $y'(t; f_0) = A[y(t; f_0)]$, and (4) $\lim_{t \rightarrow 0+} \|y(t; f_0) - f_0\| = 0$. The analogous problem, designated as PAC^n , for the equation $y^{(n)}(t) = A^n[y(t)]$ where the initial values of $y(t)$, $y'(t)$, ..., $y^{(n-1)}(t)$ are given for $t = 0$ as elements of X , is studied by means of an analysis of relations pertaining to the theory of semi-groups and a concomitant association to equations of higher order.

YAL.02:009

[Yale U. Dept. of Mathematics, New Haven, Conn.]

NOTE ON A CLASS OF DIFFUSION EQUATIONS, by R. H. Geeslin. [1958] [4]p. [AF 18(600)1127]

Unclassified

Published in Proc. Nat'l. Acad. Sciences, v. 44: 788-791, Aug. 1958.

This paper is an abstract of the author's dissertation which discusses the Cauchy problem for the diffusion equation (1): $(b(x)T_x)_x - T_t = 0$ in the space $L(-\infty, \infty)$, $b(x)$ being positive and continuous. Suggested by a paper of E. Hille [Jour. Analyse Math., v. 3: 81-196 (1954)], two cases are considered: Case 1, $B(-\infty) < \infty$ and $B(\infty) < \infty$; and case 2, $B(-\infty) = B(\infty) = \infty$; where $B(x)$ denotes $\int_0^x sb(s)^{-1} ds$. Let $\{w_n(x)\}$ and $\{\lambda_n\}$ be the characteristic values of the equation $Lu(x) = (b(x)u'(x))' = \lambda u(x)$. Then, in case 1,

$$(2): T(t)f(x) = \int_{-\infty}^{\infty} K(x, s, t)f(s)ds,$$

$$K(x, s, t) = \sum_{n=1}^{\infty} w_n(x)w_n(s)\exp(\lambda_n t),$$

gives the solution of the Cauchy problem for every $f \in D(L)$. Under the further restrictions:

$$\int_{-\infty}^{\infty} |w_n(x)| dx < C_1 |\lambda_n|^p \text{ and } \sup_x |w_n(x)| < C_2 |\lambda_n|^p$$

($p > 0$), (2) is the solution of the Cauchy problem for every $f \in L(-\infty, \infty)$. If it is assumed that L is the infinitesimal generator of a semi-group of positive contraction operators on $L(-\infty, \infty)$ — such as the case in the case 2 — and the resolvent of L has the representation

$$R(\lambda, L)g(x) = \int_{-\infty}^{\infty} G(x, s, \lambda)g(s)ds \quad (\operatorname{Re}(\lambda) > 0) \text{ with}$$

symmetric and continuous kernel G , then $G(x, s, \lambda)$ is completely monotonic and $K(x, s, t) =$

$$\lim_{\sigma \rightarrow +0} (2\sigma)^{-1} \int_{-\sigma}^{\sigma} G(x, s, \lambda) e^{\lambda t} d\lambda \text{ for } t > 0 \text{ and for any fixed } c > 0. \text{ If } \left| \int_{-\infty}^{\infty} \lambda G(x, s, \lambda) ds \right| < 1$$

($\operatorname{Re}(\lambda) > 0$), then (2) gives the solution of the Cauchy problem for every $f \in L(-\infty, \infty)$. (Math. Rev. abstract)

YAL.02:010

[Yale U. Dept. of Mathematics, New Haven, Conn.]

[REMARKS ON THE SYSTEM OF LINEAR DIFFERENTIAL EQUATIONS FOR AN INFINITE NUMBER OF UNKNOWN] Remarques sur les systèmes des équations différentielles linéaires à une infinité d'inconnues, by E. Hille. [1958] [9]p. [AF 18(600)1127]

Unclassified

Published in Jour. Math. Pures Appl., v. 37: 375-383, Oct.-Dec. 1958.

YAL.02:011; YAL.06:001, 002; YAL.07:001

Linear differential equations with an infinity of unknowns are treated in the paper. Some of the phenomena are presented in some simple cases applicable to the theory of random variables when the possible values of the variable form a denumerable set. Two special systems are studied which present a variety of striking singularities. The two systems are: $z'(t) = z(t)A$ (a differential system) and, $z_0(t) = \{z_k(t) = e^{-kt} - e^{-(k+1)t}\}$ (which is examined for zero solutions).

YAL.02:011

Yale U. [Dept. of Mathematics] New Haven, Conn.

ON ROOTS AND LOGARITHMS OF ELEMENTS OF A COMPLEX BANACH ALGEBRA, by E. Hille. [1958] [12]p. (AF 18(600)1127) Unclassified

Published in Math. Ann., v. 136: 46-57, 1958.

Let B be a non-commutative Banach algebra having unit element e and let G be the group of regular or invertible elements of B . The paper is concerned with k th roots and logarithms of elements of G , i.e., solutions x of $x^k = a$, and $\exp x = a$. If x_1 and x_2 are distinct k th roots of a such that $\sigma(x_1) \cap \sigma(\omega^j x_2) = \emptyset$ for $j = 1, \dots, k-1$ and $\omega = e^{2\pi i/k}$ ($\sigma(b)$ = the spectrum of b), the x_1 and x_2 commute, and there exist k idempotents e_j , some of which may be zero, which commute with x_1 and x_2 and are such that $e_i e_j = \delta_{ij} e_j$, $\sum_j e_j = e$ and $\sum_j \omega^j e_j = x_1 x_2^{-1}$. The proof is based on properties of the spectrum of the operator $S(b)[x] = b^{-1}xb$ for b in G . Further, if $b^k = a$, and $\sigma(b) \cap \sigma(\omega^j b) = \emptyset$, $j = 1, \dots, k-1$, then there exists a neighborhood of a of which all points are k th powers of the elements in a neighborhood of b . The condition $\sigma(b) \cap \sigma(\omega^j b) = \emptyset$ can be weakened. Similar theorems are proved for logarithms; the operator $T(a)[x] = ax - xa$ replaces the operator $S(b)$ in their derivation. (Math. Rev. abstract)

YAL.06:001

Yale U. [Dept. of Mathematics] New Haven, Conn.

A NOTE ON NONCOMMUTATIVE JORDAN ALGEBRAS, by L. J. Paige. May 1957 [4]p. (AFOSR-TN-57-230) (AF 18(603)58) AD 126527 Unclassified

Also published in Portugaliae Math., v. 16: 15-18, 1957.

Let L be an algebra over a field F of characteristic $\neq 2$, such that $x^2 = 0$ (all x in L) and such that there is a bilinear form $f(x, y)$ with values in F satisfying $f(x, y) = f(y, x)$, $f(x, yz) = f(xy, z)$ (all x, y, z in L). With t ,

s in F , an algebra $A = A(L, f, t, s)$ is constructed as follows. A consists of matrices $\begin{pmatrix} a & \alpha \\ \beta & b \end{pmatrix}$ (a, b in F ; α, β in L); addition and scalar multiplication of such matrices are defined in the obvious way, and multiplication by the rule

$$\begin{pmatrix} a & \alpha \\ \beta & b \end{pmatrix} \begin{pmatrix} c & \gamma \\ \delta & d \end{pmatrix} = \begin{pmatrix} ac + f(\alpha, \delta), & a\gamma + \alpha d + t\beta\delta \\ c\beta + b\delta + s\alpha\gamma, & f(\beta, \gamma) + b^2 \end{pmatrix}.$$

Then A is flexible, of degree 2, and hence is a non-commutative Jordan algebra. A is simple if and only if the form f is non-degenerate on L . In particular, if L is a semisimple Lie algebra of characteristic 0 and f is its Killing form, A is simple. (Math. Rev. abstract)

YAL.06:002

Yale U. [Dept. of Mathematics] New Haven, Conn.

ON JORDAN ALGEBRAS WITH TWO GENERATORS, by N. Jacobson and L. J. Paige. [1957] [12]p. (AF 18-(603)58) Unclassified

Published in Jour. Rational Mech. and Anal., v. 6: 895-906, Nov. 1957.

A proof is given that the free non-associative Jordan algebra J_0 with two generators is special. The subalgebra relative to Jordan multiplication generated by two generators in a free associative algebra F is used to develop a basis by an inductive definition. From the procedure used for J_0 , a basis is determined for J , a free Jordan algebra, which defines a set S in J in 1-1 correspondence with the J_0 basis. A sufficiency proof for the basis is given by showing that $[S]^2 \subset [S]$, where $[S]$ is the space spanned by S .

YAL.07:001

Yale U. [Dept. of Mathematics] New Haven, Conn.

SPECTRAL REPRESENTATION OF SEMIGROUPS OF NORMAL OPERATORS, by C. I. Tulcea. [1958] [2]p. (AF 49(638)153) Unclassified

Published in Proc. Nat'l. Acad. Sciences, v. 44: 44-45, Jan. 1958.

Let G be a locally compact group with Haar measure μ ; S a subset of G with: (1) $xy = yx \in S$ for all x, y in S ; (2) $\mu(U) > 0$ for all non-void $U \subset S$ open in S . Let E be the space of characters on S endowed with the topology of uniform convergence on compact sets. If \mathcal{K} is a class of relatively open and compact sets in S which covers S and $R = \{r(X) \mid X \in \mathcal{K}\}$ is a set of real numbers not less than one, let $E(R)$ be the subspace of characters $\chi \in E$ with $|\chi(t)| \leq [r(X)]^{1/2}$ for $t \in X$, $X \in \mathcal{K}$. Let H be a

YAL.08:001 - YAL.08:004

Hilbert space and let $\phi(t) = U_t$ be a weakly continuous map of S into the set of bounded normal operators on H such that $U_t U_s = U_{ts}$ for $t, s \in S$ and $\|U_t\| \leq [r(X)]^{1/2}$ for $t \in X, X \in \mathcal{U}$. The following theorem is stated. There exists a unique spectral family of measures $(\mu_{x,y})_{x,y \in H}$ on $E(R)$ such that for $t \in S, x, y \in H$, we have (a) $(U_t x | y) = \int E(R) X(t) d\mu_{x,y}(X)$; (b) $\|\mu_{x,x}\| = \|x\|^2$ for all $x \in H$, if and only if for every $x \neq 0$ there is a $t \in S$ with $U_t x \neq 0$. If E itself is locally compact and S has a non-void interior and is separable, then a similar theorem holds for the integral taken over all of E . (Math. Rev. abstract)

YAL.08:001

[Yale U. Dept. of Physics, New Haven, Conn.]

THE STRUCTURE OF SPECTRAL LINES FROM PLASMAS, by H. Margenau and G. W. Landwehr. Jan. 1, 1957, 1v. Incl. diagrs. tables, refs. (AFOSR-TN-57-56) (AF 18(603)15) AD 115095 Unclassified

Also published in Rev. Modern Phys., v. 31: 569-615, July 1959.

A fairly detailed summary and an incisive critique of the present state of the plasma broadening problem is presented. The state is shown to be unsatisfactory in several minor respects (the treatment of the cooperation of electrons and ions is still rather intuitive and is not based on a rigorous analysis; approximations connected with the use of sum rules in the section) and a major one (under study), the quantum theory of second-order Stark broadening by electrons. The statistical theory and impact-theory, velocity-broadening or phase-shift broadening theory of plasma line-broadening theory are surveyed.

YAL.08:002

Yale U. [Dept. of Physics] New Haven, Conn.

THE BALMER LINES AS INDICATORS OF THE PHYSICAL STATE OF A PLASMA (Abstract), by H. Margenau. [1957] [1]p. [AF 18(603)15] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 85, Jan. 30, 1957.

This paper reports new results of a theoretical study concerning the structure of the Balmer lines emitted in a plasma of high ion density. Reliance on the Holtsmark theory leads to two errors: (1) the theory itself requires modifications, and (2) the effect of the electrons becomes important and must be included. It is to be

shown particularly how point (2) can be treated and how the electrons modify the Holtsmark shape. The departures from that shape depend on the temperature as well as the density of electrons and should provide, in principle, an independent measure of the electron temperature. Point (1) is to be left for casual discussion.

YAL.08:003

Yale U. [Dept. of Physics] New Haven, Conn.

PRESSURE INDUCED SATELLITES (Abstract), by L. Klein. [1957] [1]p. [AF 18(603)15] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 54, Jan. 30, 1957.

A qualitative suggestion by Preston and others is utilized in an attempt to formulate a quantitative theory of the side bands accompanying the absorption lines of the alkali spectra. In accordance with that hypothesis a suitable set of interaction energy curves for the radiating atom-perturber configuration were chosen; and the statistical theory as formulated by Margenau was used. It is shown that a very general set of potential energy curves cannot lead to results in agreement with the data of Ch'en or Robin. It is suspected that the statistical theory (in its present formulation) does not account for the satellite band phenomena, no matter how peculiar the interaction curves may be, and that a model including the perturber motions (now under study) is required to explain the facts.

YAL.08:004

Yale U. Dept. of Physics, New Haven, Conn.

STARK EFFECTS IN LINE BROADENING, by H. Margenau and M. B. Lewis. [Jan. 1957] 23p. [AF 18(603)15] Unclassified

Presented at Internat'l. Colloquium on the Optical and Acoustical Properties of Compressed Fluids and Molecular Interactions, Laboratoires de Bellevue, France, July 1-6, 1957.

Also published in Phys. Rev., v. 106: 244-250, Apr. 15, 1957.

Earlier calculations, based on customary radiation theory, fail to yield a meaningful finite answer for the second-order Stark effect upon line broadening (Part I). The reason for this occurrence is found in the assumption that, at some definite time, the radiating atom, as well as the perturbing electron, is in a precise energy state. When the electron is represented in a suitable way by a wave packet, a finite line width results

YAL.08:005, 006; YAL.03:007, 008

(Part II), and this answer agrees within reasonable limits with that of the classical impact theory, provided certain conditions, enumerated at the end of Part II, are satisfied. (Contractor's abstract)

YAL.08:005

Yale U. Dept. of Physics, New Haven, Conn.

STATISTICAL BROADENING OF SPECTRAL LINES EMITTED BY IONS IN A PLASMA, by M. [B.] Lewis and H. Margenau. [1958] [4]p. Incl. diagr. tables. (AF 18(603)15) Unclassified

Published in Phys. Rev., v. 109: 842-845, Feb. 1, 1958.

The Holtsmark theory of line broadening omits the factor $e^{-V_{ij}/kT}$ in the evaluation of probabilities, where V_{ij} is the Coulomb interaction between the i th and the j th ions. This leads to serious errors in the wings of a line where frequency shifts arise from close encounters which are inhibited by the Boltzmann factor. In part I of the present article a consistent binary approximation to the line shape is given, the assumption being made that only a single perturber is involved in a collision. Part II treats the case of many particles, retains V_{ij} for all perturbers j interacting with a single radiating ion i , but ignores forces between the perturbers themselves. Comparison is made with other treatments. (Contractor's abstract)

YAL.08:006

Yale U. [Dept. of Physics] New Haven, Conn.

FINE STRUCTURE PRESSURE EFFECTS (Abstract), by L. Klein and H. Margenau. [1958] [1]p. (AF 18(603)15) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 214, May 1, 1958.

The Van der Waals dipole-dipole perturbation energy is calculated for the fine structure levels of an alkali atom interacting with noble gas atoms. A general expression for the interaction energy caused by n simultaneously acting perturbers is developed for the $^2P_{1/2}$ and $^2P_{3/2}$ levels of the alkali atom. Shift and broadening of these two components are calculated as functions of noble gas density by the use of a statistical theory. It is found that the theory predicts a red shift which is nearly linear with density, the $^2P_{3/2}$ compo-

nent being shifted slightly more than the $^2P_{1/2}$. This is in agreement with the experimental data for heavy noble gases. The half-widths predicted are slightly less than the experiments indicate, but the discrepancy is within the limits of accuracy of the theory. Because of neglect of exchange effects and higher than dipole interactions, the treatment is restricted to densities below 100 rd.

YAL.03:007

Yale U. Hammond Metallurgical Lab., New Haven, Conn.

STRUCTURE SENSITIVITY OF THE LOW-TEMPERATURE IONIC CONDUCTIVITY OF NaCl CRYSTALS, by D. B. Fischbach and A. S. Nowick. Jan. 1957 [16]p. Incl. diagr. refs. (Technical note no. 5) (AFOSR-TN-57-22) (AF 18(600)850) AD 115056 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 2: 226-231, 1957.

Measurements of the steady-state ionic conductivity of synthetic crystals of NaCl in the temperature range from 20° to 100°C are reported. It is found that annealing increases the conductivity over the value in the "as-received" condition, while plastic deformation followed by low-temperature recovery reduces it. Neither treatment affects the activation energy, which is found to be 1.07 ± 0.05 ev. The results further indicate that the structure sensitivity of the steady-state conductivity is not related to the space-charge polarization phenomenon. Comparison of the present data with earlier results on the structure sensitivity of the x-ray coloration of similar crystals suggests that in both cases the effects of thermal and mechanical treatment are probably due to changes in the state of dispersion of impurities.

YAL.03:008

Yale U. Hammond Metallurgical Lab., New Haven, Conn.

RECOVERY OF INTERNAL FRICTION AND ELASTIC CONSTANTS, by A. S. Nowick. [1957] [30]p. Incl. diagr. tables, refs. (AFOSR-TN-57-447) (AF 18(600)850) Unclassified

Also published in "Creep and Recovery"; a Seminar, Cleveland, Ohio (Oct. 6-7, 1956), Cleveland, Amer. Soc. for Metals, 1957, p. 146-175.

A freshly cold-worked metal shows a modulus defect and a relatively high value of internal friction due to the presence of dislocation loops which are capable of bowing out under an applied stress. Recovery of the damping and modulus after deformation is extremely rapid, so that minutes after deformation at room temperature (even of a high melting point metal) large

YAL.03:009, 010; YAL.04:018, 019

changes in these properties already have taken place. The modulus defect and internal friction in heavily deformed metals are attributed to the relatively free dislocations within the subgrain structure, and are regarded as not influenced by dislocations that form the subgrain boundaries. The dependence of damping and modulus defect on deformation temperature is such that (for equivalent anneals) the effects are larger the higher the deformation temperature. Two theories of the recovery of the damping and modulus are discussed. The first theory assumes that point defects created by the deformation pin the dislocation segments to produce recovery, while the second considers that dislocation rearrangement is responsible for the recovery.

YAL.03:009

Yale U. [Hammond Metallurgical Lab.] New Haven, Conn.

SOME TRANSIENT ELECTRICAL EFFECTS OF PLASTIC DEFORMATION IN NaCl CRYSTALS, by D. B. Fischbach and A. S. Nowick. Aug. 1957 [41]p. incl. diagrs. refs. (Technical note no. 6) (AFOSR-TR-57-55) (AF 18(600)850) AD 136474 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 5: 302-315, 1958.

Transient electrical effects of plastic deformation in NaCl crystals have been investigated. Two such effects have been observed: (1) a temporary increase in the ionic conductivity; and (2) a deformation-induced charge flow with no applied electric field. The first effect, which is observable for about an hr at room temperature, is attributed to excess vacancies freed by moving dislocations. It is suggested that an important source of these vacancies may be the break-up of associated complexes between cation vacancies and multivalent cation impurities. The second effect is observed only following inhomogeneous plastic deformation, and ceases abruptly when the stress increment producing it is removed. Possible sources for this deformation-induced charge flow are discussed and an explanation is offered in terms of electrically charged dislocations. (Contractor's abstract)

YAL.03:010

Yale U. [Hammond Metallurgical Lab.] New Haven, Conn.

LATTICE IMPERFECTIONS IN METALLIC AND IONIC CRYSTALS, by A. S. Nowick. Final rept. July 1, 1953-Aug. 31, 1957, 6p. (AFOSR-TR-57-56) (AF 18(600)850) AD 136504 Unclassified

The work completed under this contract concerns the interaction between point defects and dislocations. This study was originally begun with the objective of utilizing certain properties of the alkali halide crystals which are uniquely adapted to the study of such

interactions as their electrical and optical properties. The work subsequently branched out into a study of the pinning of dislocations by x-irradiation through the use of precision elastic modulus measurements (obtained from resonant frequencies) and internal friction measurements. Finally, the work was further expanded to include the study of the modulus and internal friction of metals in relation to the pinning of dislocations by quenched-in defects. Each of the above mentioned branches of the work are described in further detail.

YAL.04:018

Yale U. [Sloane Physics Lab.] New Haven, Conn.

INFORMATION OBTAINABLE ON POLARIZATION OF μ^+ AND ASYMMETRY OF e^+ IN MUONIUM EXPERIMENTS, by G. Breit and V. W. Hughes. Mar. 13, 1957, 12p. incl. tables. (AFOSR-TN-57-117) (AF 18-600)771 and AF 18(600)1565) AD 120470 Unclassified

Also published in Phys. Rev., v. 105: 1293-1295, June 15, 1957.

The formation of the compound $\mu^+ + e^-$ (muonium) is considered as a tool for gaining information regarding the polarization of the μ^+ before their capture by the e^- and the asymmetry of the e^+ emission in the disintegration $\mu^+ \rightarrow e^+ + \nu + \bar{\nu}$. The detection of asymmetry effects is supposed to take place through the counting of e^+ . The effect of constant magnetic fields and of microwave induced transitions among magnetic substates of muonium is calculated with the conclusion that all of the experiments considered here determine in different ways the same combination of parameters describing the initial muon polarization and the asymmetry of e^+ emission in muon decay. (Contractor's abstract)

YAL.04:019

Yale U. [Sloane Physics Lab.] New Haven, Conn.

VACUUM POLARIZATION EFFECTS IN PROTON-PROTON SCATTERING, by L. Ivarsen, III. [1957] [51]p. incl. diagrs. tables, refs. (AFOSR-TN-57-420) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)771 and Office of Ordnance Research) AD 132499 Unclassified

Also published in Phys. Rev., v. 108: 1597-1610, Dec. 15, 1957.

The problem of vacuum polarization scattering of protons by protons is treated to first order in the vacuum polarization interaction. The phase shifts caused by the interaction are calculated, and the corresponding addition to the p-p scattering matrix is constructed, including exactly the effects on the phase shifts and scattering. Other electromagnetic and relativistic modifications

YAL.04:020 - YAL.04:023

of the Coulomb scattering amplitudes are also examined in the limit of low energies. Numerical results are given for the vacuum polarization contributions to the p-p scattering cross section over the energy range 1.4 to 4.2 mev. It is found that vacuum polarization scattering may easily be confused with nuclear p wave scattering.

YAL.04:020

Yale U. Sloane Physics Lab., New Haven, Conn.

THEORY OF THE ISOTOPE SHIFT, by G. Breit.
Jan. 8, 1958, 33p. diagrs. refs. (AFOSR-TN-58-30)
(AF 18(600)771) AD 148069 Unclassified

Also published in Rev. Modern Phys., v. 30: 507-516,
Apr. 1958.

Existing theories of the spectroscopic isotope shift are reviewed and the assumptions made in them are examined. In the early development of nuclear physics the existence of agreement as to order of magnitude between expectation and experiment was of interest in corroborating general views regarding nuclear structure. Later more difficult attempts to obtain quantitative agreement naturally suffer from arbitrariness in the assumptions regarding the effect on the nuclear charge distribution of adding a neutron to those already present. There is no doubt regarding the correlation between the variations of the intrinsic quadrupole moment of the collective model and the magnitude of the isotope shifts, but the quantitative aspects of this interpretation are not settled. Similarly it is not clear which of the various proposals for the understanding of even-odd staggering has the closest bearing on the observed phenomenon and the smallness of the isotope shift in comparison with expectation on the incompressible fluid model with the $A^{1/3}$ proportionality of the nuclear radius is understood only qualitatively. There appears to be no reason for believing, however, that the observed facts will not agree with currently accepted models of nuclear structure when these are developed to the point of making it possible to perform the necessary calculations. The main reason for the difficulty in providing a quantitatively reliable treatment is the extreme smallness of the change in nuclear charge distribution which often corresponds in order of magnitude to a change in the nuclear radius by 1/600 of its value.

YAL.04:021

Yale U. [Sloane Physics Lab.] New Haven, Conn.

THE EFFECTS OF VACUUM POLARIZATION SCATTERING IN THE TREATMENT OF PROTON-PROTON SCATTERING DATA, by M. de Wit and L. Durand, III.
May 9, 1958 [32]p. incl. diagrs. tables, refs. (AFOSR-

TN-58-402) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)771 and Atomic Energy Commission under AT(30-1)1807) AD 158210
Unclassified

Also published in Phys. Rev., v. 111: 1597-1603, Sept. 15, 1958.

The effects of including vacuum polarization scattering in angular momentum states with $L > 0$ and the effects of employing the relativistic value of the Coulomb scattering parameter η_r rather than its non-relativistic value η have been considered in the analysis of low-energy p-p scattering data. It has been found that about half of the apparent mean p wave phase shift present in published data, in the energy range 1.8 - 4.2 mev, should be attributed to this vacuum polarization scattering. A further decrease in magnitude of the p wave is obtained when η_r is employed, rather than η . Both the vacuum polarization scattering in states with $L > 0$ and the employment of η_r rather than η result in a contribution to the f function which does not vary linearly with energy. The effects of these contributions on the coefficients of a polynomial expansion of $f(E)$ are ascertained with reference to p-p scattering data in the energy range 0.2 to 7.5 mev. The object of the work is more that of investigating the possible magnitude of effects on conclusions drawn from data due to applying the various corrections than that of deriving final phase shift values. (Contractor's abstract)

YAL.04:022

Yale U. [Sloane Physics Lab.] New Haven, Conn.

EFFECTS OF ATOMIC ELECTRONS ON p-p AND n-p SCATTERING, by G. Breit. Aug. 15, 1958, 6p. (AFOSR-TN-58-730) (AF 18(600)771) AD 162265 Unclassified

Also published in Phys. Rev. Letters, v. 1: 200-203,
Sept. 15, 1958.

Consideration is given to the possibility that the screening effect, hitherto assumed to be small, may prove to be non-negligible at low energies (<10 mev). Coulomb excitation of the molecular electrons and acceleration of the target atoms are considered. These effects interfere with the employment of low energy data for p-wave anomaly detection and increase the relative importance of higher energy work.

YAL.04:023

Yale U. [Sloane Physics Lab.] New Haven, Conn.

METASTABILITY OF 2s STATES OF HYDROGENIC ATOMS, by J. Shapiro and G. Breit. Sept. 4, 1958,

YAL.04:024 - YAL.04:026

11p. (AFOSR-TN-58-817) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-771 and Office of Ordnance Research) AD 202642
Unclassified

Also published in Phys. Rev., v. 113: 179-181, Jan. 1, 1959.

A new calculation of the transition probability of the decay of metastable hydrogen in the 2s state by means of double photon emission is given, and the results are compared to previous bounds established for this process. The transition probability for any hydrogenic atom with atomic number Z is given to be $8.226 Z^6 \text{ sec}^{-1}$. Relativistic effects on the wave function have been neglected in the calculations which are therefore accurate only for small Z . (Contractor's abstract, modified)

YAL.04:024

Yale U. [Sloane Physics Lab.] New Haven, Conn.

NATURAL LINE WIDTH FOR TRANSIENT EXCITATIONS, by G. Breit and M. H. Hull, Jr. Sept. 25, 1958, 26p. diagr. (AFOSR-TN-58-906) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)771 and Atomic Energy Commission under AT(30-1)1807) AD 204516
Unclassified

Also published in Astrophys. Jour., v. 129: 456-467, Mar. 1959.

The absorption of a photon by a material system with 4 participating levels A B C D is studied with special attention to the case in which the levels are the result of combining excitations of separate systems from $a - a'$ and from $b - b'$ with the identification of A B C D with (a,b), (a,b'), (a',b), (a',b') respectively. The absorption width of the BD transition is shown to approach the limit expected for the decoupled system as the parameters corresponding to the decoupled condition are made to approach their special values. It is similarly shown how the formulas for rescattering by the general system approach those for the decoupled system. It is found that the procedure of folding the radiation widths of upper and lower levels in a radiation transition in order to obtain the width of an absorption or emission line must be used with care, and that the circumstances entering the excitation of the levels need consideration. Correlations in photon magnitudes in double photon emission and absorption enter some of the considerations. The consideration of the double photon emission solution is used as an illustration of the role of the ratio of the strength of coupling between electrons to the natural line width. (Contractor's abstract)

YAL.04:025

Yale U. [Sloane Physics Lab.] New Haven, Conn.

ELECTRIC POLARIZABILITY OF THE NEUTRON, by G. Breit and M. L. Rustgi. Dec. 3, 1958, 25p. (AFOSR-TN-58-1063) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)771 and Office of Ordnance Research) AD 207233; PB 138352
Unclassified

Also published in Phys. Rev., v. 114: 830-837, May 1, 1959.

In connection with a proposed explanation of the anisotropy observed in the scattering of neutrons from various elements at energies of a few hundred kev, the order of magnitude of the neutron polarizability is estimated making use of data on photopion production. A

polarizability α greater than $\sim 2 \times 10^{-42} \text{ cm}^3$ appears unlikely on this basis. There remains an unexplained factor of ~ 50 which has to be accounted for either in the polarizability or by providing another explanation of the neutron scattering anisotropy. The possibility of explaining the anisotropy on the basis of ordinary scattering theory does not appear to be excluded. The exact proportionality of the coefficient of $\cos \theta$ to the neutron momentum does call for an r^{-4} type of potential, but it is not clear whether the energy dependence of the coefficient is sufficiently well determined by the data and whether the compound nucleus features of the interaction are capable of explaining the observations. Nevertheless a few less usual effects are estimated. These are the interaction of the neutron moment with the vacuum polarization charge and with the external electric field of the nucleus as well as its interaction with the electric charge density at the nuclear surface. The latter is hard to distinguish from other nuclear effects. The former two effects are small and do not resemble the observed effects. (Contractor's abstract)

YAL.04:026

Yale U. [Sloane Physics Lab.] New Haven, Conn.

SECOND ORDER EFFECTS IN COULOMB EXCITATION, by G. Breit. [1958] [2]p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)771 and Atomic Energy Commission under AT(30-1)1807)
Unclassified

Published in Internat'l. Congress on Nuclear Phys., Paris (France) (July 7-12, 1958), Paris, Dunod, 1959, p. 347-348.

Second order effects in Coulomb excitation have been considered as a means of determining multiple matrix elements between nuclear energy levels. Most of the calculations of second order effects have been made

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in the semi-classical approximation for the relative motion of target and projectile. The validity of the approximation was examined in the special case of the excitation of the $2+$ level of Pt^{195}

YAL.09:001

Yale U. [Sloane Physics Lab.] New Haven, Conn.

PRODUCTION OF TRIPLET P STATES OF HELIUM IN A BEAM (Abstract), by J. A. White, V. W. Hughes and others. [1957] [1]p. [AF 18(600)1565] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 37, Jan. 30, 1957.

The $M = +1$ magnetic substate of a refocused beam of metastable $^3\text{S}_1$ He atoms was selected by use of a wire stop in an atomic beam magnetic resonance apparatus. Unpolarized light from a low voltage, 60-w helium arc lamp (Osram spectral lamp) caused a defocusing of about 10% of the refocused beam, which corresponds to a detected signal of 2×10^{-14} amp. The defocusing (light flop) is interpreted as due to a change in M value which can be associated with the process of excitation of a $^3\text{S}_1$ atom to a ^3P state and its subsequent decay back to the $^3\text{S}_1$ state. The use of optical filters indicated that the excitation is primarily to the $1s\ 2p\ ^3\text{P}$ states, which occurs at a wavelength of 10 830 Å. The amount of defocusing agrees in order of magnitude with the theoretical estimate. The production of the $n = 2$, ^3P states of He in a beam should allow a high precision measurement of the fine structure separations of these states by a combined optical-microwave atomic beam magnetic resonance method.

YAL.09:002

Yale U. [Sloane Physics Lab.] New Haven, Conn.

ZEEMAN EFFECT OF NEON AND ARGON IN METASTABLE $^3\text{P}_2$ STATE (Abstract), by C. Drake, V. W. Hughes, and A. Lurio. [1957] [1]p. [AF 18(600)1565] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 30-Feb. 2, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 37, Jan. 30, 1957.

The electronic g_J values of neon and argon in their metastable $^3\text{P}_2$ state have been measured by the atomic beam magnetic resonance method. The metastable atoms were produced in a glow discharge and detected by electron ejection from a wire. The magnetic field of about 550 gauss was calibrated by use of a Zeeman transition in the metastable $^3\text{S}_1$ state of helium. The theoretical g values were calculated to the experimental precision taking into account quantum electrodynamic and relativistic contributions and state perturbations. The experimental and theoretical results agree and are

	g_J (exptl.)	g_J (theoret.)
Ne	1.5009 ± 0.0001	1.5009 ± 0.0001
Ar	1.5009 ± 0.0001	1.5010 ± 0.0001

The Zeeman transition in the metastable $^3\text{P}_2$ state of krypton was observed with an intensity considerably less than that for Ne and Ar.

YAL.09:003

Yale U. [Sloane Physics Lab.] New Haven, Conn.

REMARKS ON FORMATION OF MUONIUM IN GASES (Abstract), by V. W. Hughes. [1957] [1]p. [AF 18(600)-1565] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 25-27, 1957.

Published in Bull. Amer. Phys. Soc., Series II, v. 2: 205, Apr. 25, 1957.

The existence of polarized μ^+ mesons from the π^+ decay and the angular asymmetry in the distribution of e^+ decays from μ^+ , which are associated with parity non-conservation, may make possible studies of the hyperfine structure (hfs ≈ 4500 mc/sec) of the bound state of a μ^+ meson and an electron (muonium). With this motivation estimates have been made of cross sections relevant to the formation of muonium in gases. At kinetic energies of order $(e^2/a_0)(m_\mu/m_e)$, for which the μ^+ meson's velocity is comparable to the velocities of electrons in a gas molecule, the cross section for the capture of an electron by a μ^+ meson is of the order πa_0^2 ; the cross section for the ionization of muonium is of similar magnitude. At sufficiently low kinetic energies so that the breakup of muonium is energetically forbidden the cross section is several orders of magnitude smaller. For a gas with an ionization energy less than the binding energy of muonium (13.5 ev) muonium formation competes with decay of the free μ^+ meson and with attachment of μ^+ to a gas molecule. For a gas with ionization energy

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greater than 13.5 ev the μ^+ meson may fall below the threshold for muonium formation due to inelastic and elastic collisions and will then decay without forming muonium.

YAL.09:004

Yale U. Sloane Physics Lab., New Haven, Conn.

EXPERIMENTAL LIMIT FOR THE ELECTRON-PROTON CHARGE DIFFERENCE, by V. W. Hughes. [1957] [3p. incl. diagrs. table. (AFOSR-TN-58-234) (AF 18(600)1565) AD 129102 Unclassified

Also published in Phys. Rev., v. 105: 170-172, Jan. 1, 1957.

By a study of the deflection of a beam of CsI molecules in a homogeneous electric field an upper limit is established for the charge on a CsI molecule. This upper limit is 1.7×10^{-22} esu or 4×10^{-13} of the electronic charge, and implies that the magnitude of the electron-proton charge difference is less than 3×10^{-15} of the electronic charge or that the charge on a neutron is less than 2×10^{-15} of the electronic charge.

YAL.09:005

Yale U. [Sloane Physics Lab.] New Haven, Conn.

CONSIDERATIONS ON DEPOLARIZATION OF POSITIVE MUONS IN GASES; EFFECT OF MOLECULAR IONS, by V. W. Hughes. [1957] [2p. incl. refs. (AFOSR-TN-58-235) (AF 18(600)1565) AD 214896 Unclassified

Also published in Phys. Rev., v. 108: 1106-1107, Nov. 15, 1957.

A mechanism for the depolarization of positive mesons in matter is presented. The author suggests that depolarization may be due to the attachment of a μ^+ meson to a neutral gas atom or molecule in contrast to the previous mechanism whereby depolarization is effected by the formation of muonium ($\mu^+ e^-$).

YAL.09:006

Yale U. [Sloane Physics Lab.] New Haven, Conn.

ATOMIC g_J VALUES FOR NEON AND ARGON IN THE METASTABLE 3P_2 STATE (Abstract), by A. Lurio, C. Drake and others. [1958] [1p. (AF 18(600)1565) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 8, Jan. 29, 1958.

The ratios of the electronic g_J values of Ne and A in their metastable 3P_2 state to the g_J of He in its metastable 3S_1 state have been redetermined by the atomic beam magnetic resonance method using separated oscillatory fields. At a magnetic field of 550 gauss transitions between Zeeman levels of Ne or A and of He are observed at frequencies of approximately 1157 mc/sec and 1543 mc/sec. If the known value $g_J(\text{He}) = 2[1.001183(8)]$ is used, the results obtained are $g_J(\text{Ne}, ^3P_2)_{\text{exptl}} = 1.500888(5)$ and $g_J(\text{A}, ^3P_2)_{\text{exptl}} = 1.500964(8)$. Relativistic corrections to the Lande g_J value of 1.5 for a 3P_2 state have been computed using Slater wave functions. If these corrections are combined with the spin g_s value for the electron of $g_s = 2(1.0011596)$, the following theoretical values are obtained: $g_J(\text{Ne}, ^3P_2)_{\text{theoret}} = 1.50088$ and $g_J(\text{A}, ^3P_2)_{\text{theoret}} = 1.50106$. The agreement of the experimental and theoretical g_J values for Ne is excellent; the discrepancy for A may be due to the effects of configuration interaction which are not included in the theoretical value.

YAL.09:007

Yale U. [Sloane Physics Lab.] New Haven, Conn.

DEPOLARIZATION OF POSITIVE MUONS IN GASES; SEARCH FOR MUONIUM (Abstract), by V. W. Hughes, A. Lurio and others. [1958] [1p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Office of Naval Research, and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 51, Jan. 29, 1958.

The depolarization of positive muons stopped in various gases has been studied in an experiment similar to that of Garwin, Lederman, and Weinrich. The gases at pressures from 20 to 60 atmos were contained in a thin-walled stainless steel cylinder 12 in. in length and 6 in. in diameter. The peak and valley gated positron counting rates were measured at the appropriate values of the magnetic field which causes the precession of the muon spins. The fraction of the total counts which arises from muons stopping in the gas is between about 1/3 and 2/3. The following values are obtained for the ratios of peak counts (P) to valley counts (V):

YAL.09:008, 009

Gas and cylinder	Pressure (psi)	P/V
Cylinder alone	...	1.79 ± 0.09
A	825	1.25 ± 0.05
SF ₆	300	1.49 ± 0.06
SF ₆ + Xe	300(Xe-2)	1.54 ± 0.09
SF ₆ + NO	225(NO-90)	1.38 ± 0.18
N ₂ O	700-800	1.04 ± 0.04
CO ₂	700	1.43 ± 0.15
O ₂	900	1.55 ± 0.14

YAL.09:008

Yale U. [Sloane Physics Lab.] New Haven, Conn.

FURTHER EVIDENCE FOR MUONIUM FORMATION IN N₂O (Abstract), by D. McCollm, V. W. Hughes and others. [1958] [1]p. [AF 18(600)1565] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 229, May 1, 1958.

In a previous paper the particularly large depolarization of positive muons stopped in N₂O gas was reported for an experiment similar to that of Garwin, Lederman, and Weinrich. One explanation for the low observed value of (peak counts)/(valley counts) is the abundant formation of muonium. To test this possibility further the effect of a small magnetic field H_z along the direction of the incoming muon beam on the positron counting rate parallel to this direction has been measured. The positron counting rate arising from μ -meson decays is observed under two field conditions: (i) H_z = 0 and a vertical field H_y = 2 gauss, (ii) H_z = 15 gauss; H_y = 2 gauss. A change in counting rate by a factor 1.09 ± 0.02 is found without correction for background. If π mesons are stopped in the gas, the corresponding measurement gives 1.01 ± 0.01 . With the assumptions that all muons form muonium in its ground state and that the magnetic substates are unequally populated as expected for

initially polarized muons, a ratio of counting rates equal to about 1.16 is expected due to the retention of the polarization of the $m = -1$ magnetic substate in the H_z field. It is felt that the result of this experiment adds considerable support to the view that muonium formation occurs for muons stopped in N₂O.

YAL.09:009

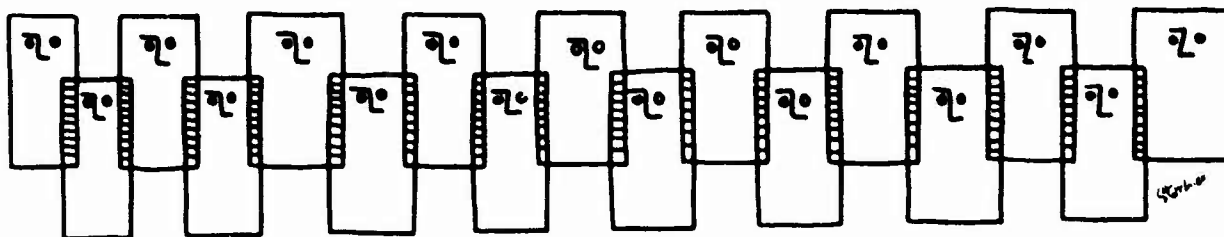
Yale U. [Sloane Physics Lab.] New Haven, Conn.

MAGNETIC MOMENT OF MU-MESONIC ATOMS (Abstract), by V. W. Hughes and V. L. Telegdi. [1958] [1]p. [AF 18(600)1565] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 3: 229, May 1, 1958.

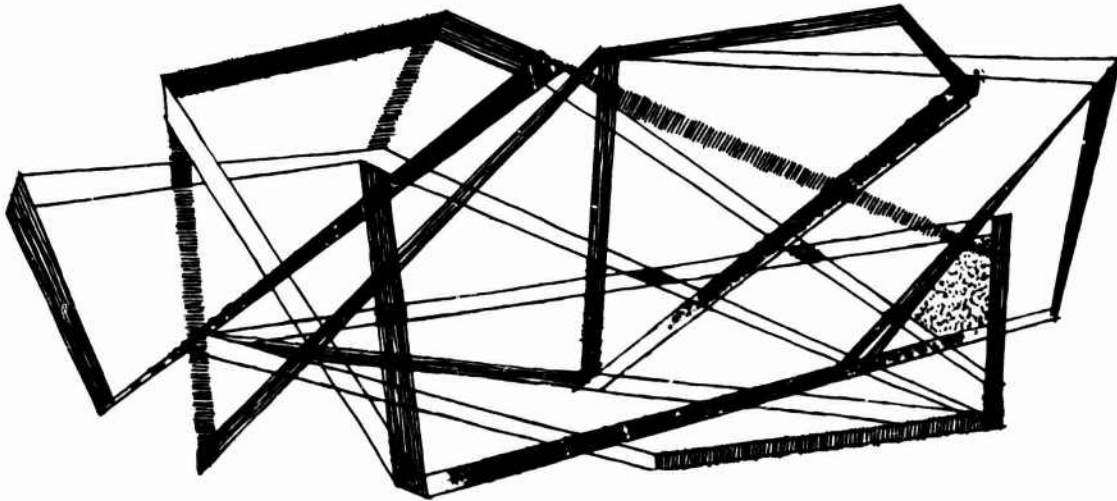
Nonconservation of parity in the decay of π and μ mesons may make possible precise measurements of the magnetic moment of mu-mesonic atoms in their ground S_{1/2} state by the observation of Zeeman transitions. The magnetic moment, m , of the μ meson attached to a nucleus of charge +Ze and spin I = 0 differs from the magnetic moment, m_μ , of the free μ meson by a relativistic binding factor which can be calculated from the Dirac equation for the mu-meson atom. For a point charge model of the nucleus $m = m_\mu [1 - \alpha^2 Z^2 / 3]$, in which α is the fine structure constant. For an extended spherically symmetric nucleus, $m = m_\mu [1 - 2\langle T \rangle / (3m_\mu c^2)]$, in which m_μ = mass of mu meson and $\langle T \rangle$ is the expectation value of the kinetic energy of the mu meson in the mesonic atom. For lead, $\alpha^2 Z^2 / 3 = 0.12$. Since the radius of a mu-mesonic atom with large Z is of the order of the nuclear radius, the two expressions for the correction to the magnetic moment give values which differ by a substantial fraction of the correction itself (~1/2 for Pb). Hence, the precise measurement of these magnetic moments may offer a useful tool for the study of nuclear structure.



Zwicky, F., Pasadena, Calif.

Zwicky. Final technical rept. July 31, 1955, 56p. incl. diags. refs. (AFOSR-TR-57-53) (AF 18(600)488)
AD 136461 Unclassified

attempting to explain the low yield strength of many crystals in particular and structure sensitive properties in general. Attention is called to experiments by Straumanis (Zeitschr. physik. Chem. (Leipzig) B, v. 13: 316, 1931), Gilman and Johnston (Rept. No. 57-RL-1662, Jan. 1957), and others which prove that glide bands, either directly or indirectly, through the formation of dislocations, can be produced in perfect crystals as a result of the application of shearing stresses which are very much smaller than those necessary to produce slip in ideal atomic lattices. These results suggest that the crystals must contain secondary structures characterized by secondary lattice constants which are many times greater than the primary lattice constants. A morphological analysis was made of possible fundamental effects which might cause the formation of secondary structures in thermodynamically stable crystals. Experimentation was initiated with small blocks of single crystals by compressing them against polished surfaces of different hardnesses.



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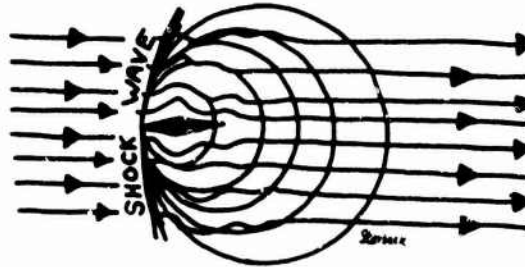
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634	ROC. 02:011	700	SIT. 01:004
636	BOS. 02:011	701	MMU. 02:002
637	MDU. 10:009	702	VIT. 01:004
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67	MMU. 02:004	128	PIB. 12:003
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